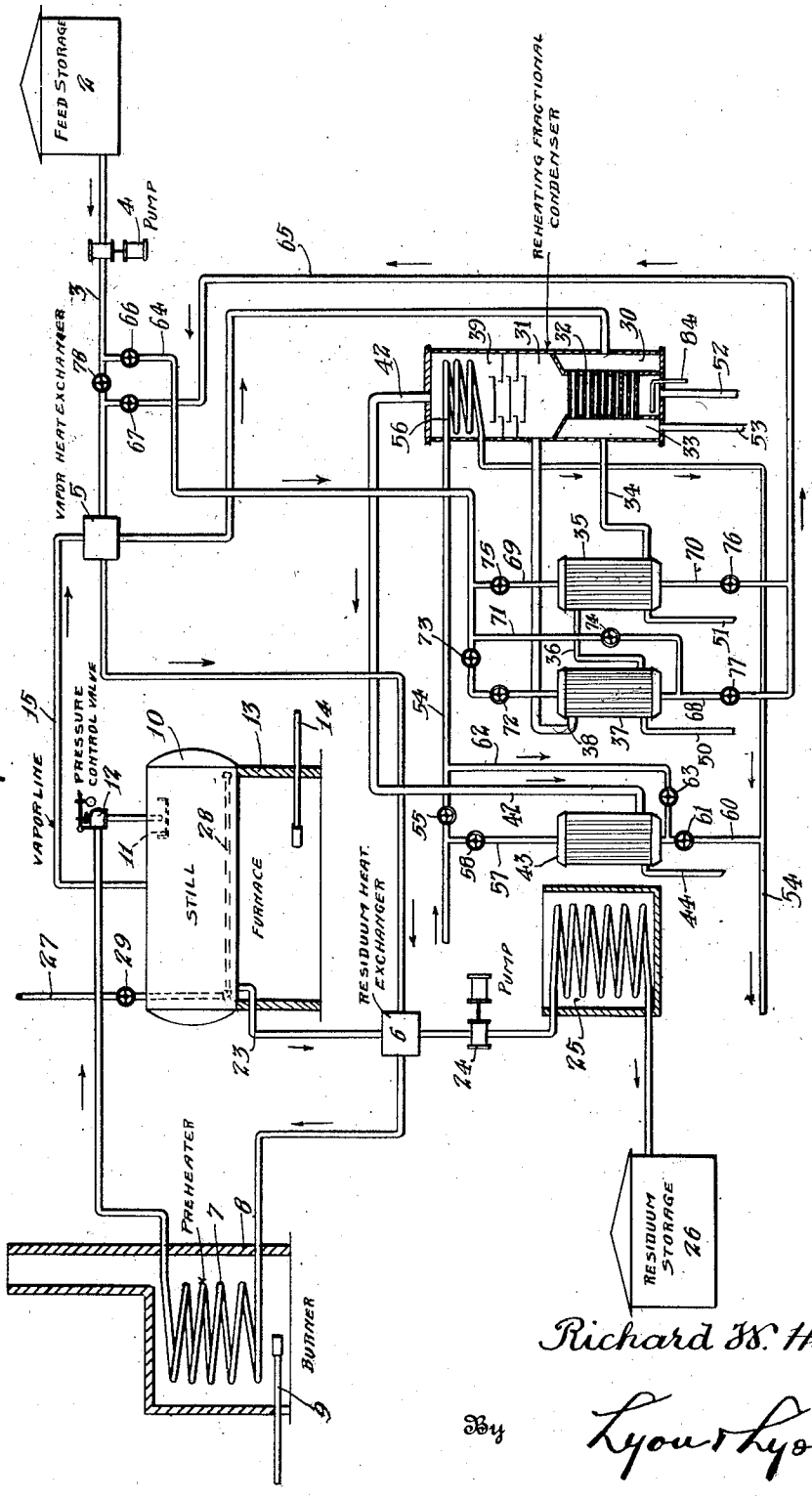
Sept. 24, 1929. R. W. HANNA 1,729,215

ART OF DISTILLATION OF PETROLEUM OILS

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Fig. 1



Inventor
Richard W. Hanna

By Lyon & Lyon
Attorneys

Sept. 24, 1929. R. W. HANNA 1,729,215

ART OF DISTILLATION OF PETROLEUM OILS

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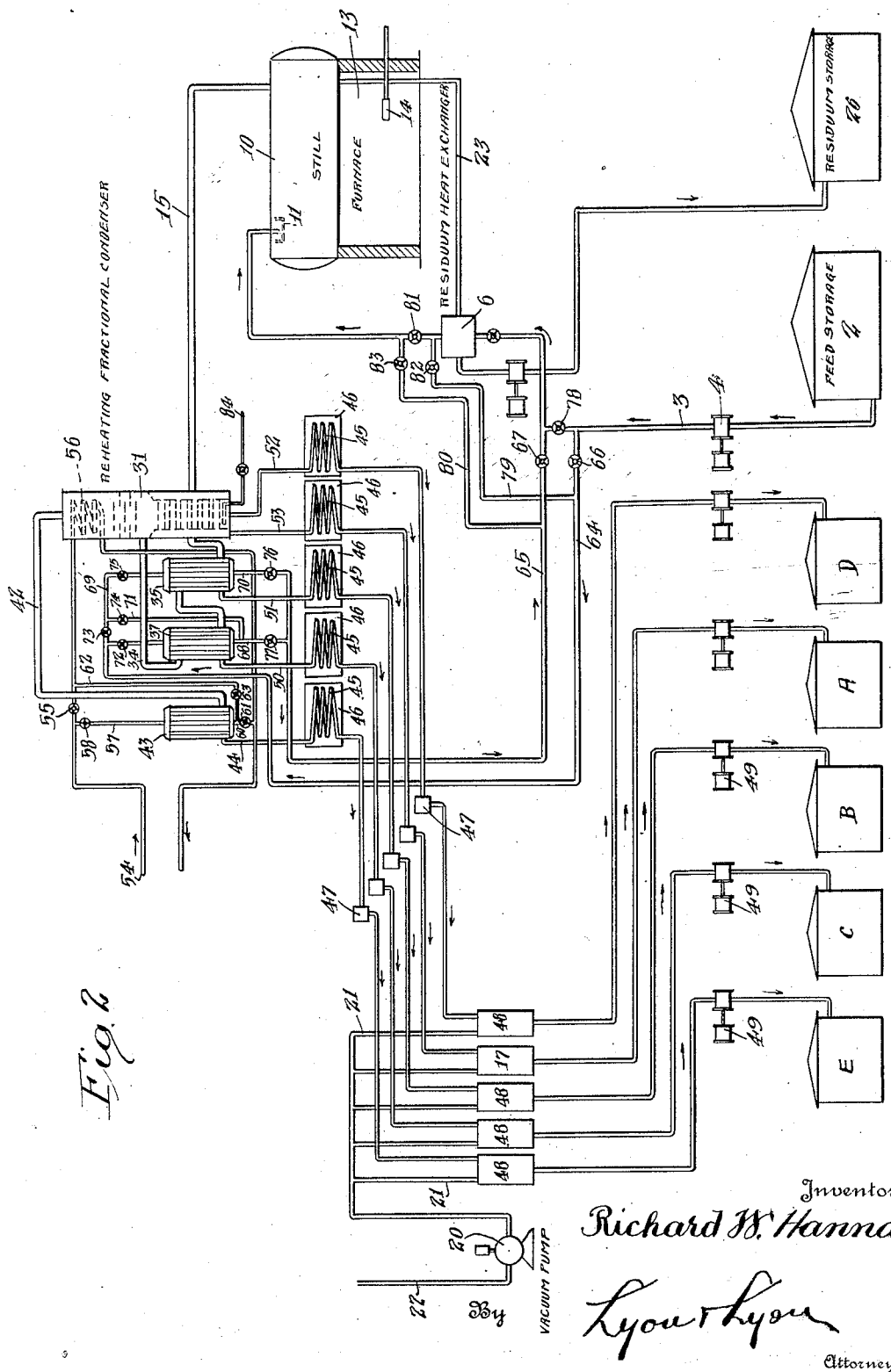


Fig. 2

Inventor
Richard W. Hanna

By Lyon & Lyon

Attorneys

Sept. 24, 1929. R. W. HANNA 1,729,215

ART OF DISTILLATION OF PETROLEUM OILS

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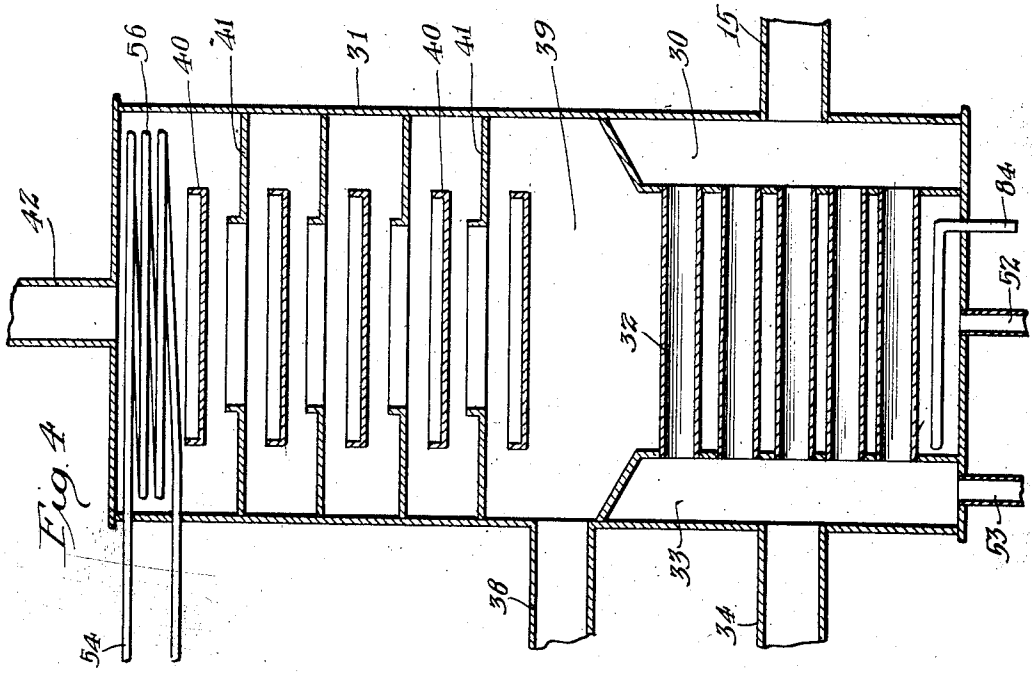


Fig. 4

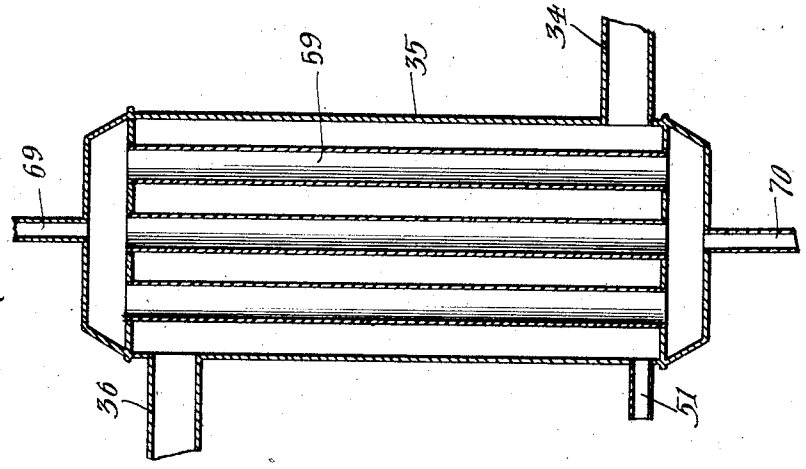


Fig. 3

Inventor

Richard W. Hanna

By Lyon & Lyon

Attorneys

Patented Sept. 24, 1929 1,729,215

UNITED STATES PATENT OFFICE

RICHARD W. HANNA, OF PIEDMONT, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO STANDARD OIL COMPANY OF CALIFORNIA, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF DELAWARE

ART OF DISTILLATION OF PETROLEUM OILS

Application filed October 4, 1923. Serial No. 666,474.

This invention relates to the art of petroleum distillation. It has to do particularly with a distillation method by which a number of different and desired fractions are produced from a base stock and is of particular use in the vacuum distillation of lubricating oil stocks.

In certain petroleum distillation operations it is desirable to separate the distillate obtained from base (petroleum) stocks into a number of different fractions or cuts possessing different ranges of boiling points with corresponding ranges in viscosity, gravity, and other characteristics. Such a separation of various fractions is desirable in the production of lubricating oils where the different grades may range from the lightest lubricating oils to the heaviest cylinder oils. Such fractional separation is not limited, however, to the lubricating oil distillates, but may apply to the lighter fractions obtained from petroleum, such, for example, as the motor oil, lamp oil and gas oil cuts.

To obtain the desired fractions of lubricating oil stocks, it has heretofore been the custom either to employ batch operation wherein the different cuts or fractions have been thrown over by holding the distilling unit at successively increasing stages of temperature or to employ a continuous operation with a number of distilling units arranged in a series and each succeeding unit of the series held at a progressively increasing temperature. In either case the different boiling-point fractions are removed in the order of their vaporizing temperatures.

In producing a number of different cuts or fractions of lubricating oil stock, difficulty is encountered by the presence, in the base stock from which the lubricating oil fractions are obtained, of light fractions which have not been entirely removed during the topping operations which take place prior to the removal from the crude petroleum of the lubricating oil fractions. There may also be present, in the stock from which the lubricating oils are distilled, the so-called gas oil cut. Still other light and relatively low-boiling-point constituents are generally present in the lubricating oil stock being distilled, due to the slight cracking which takes place at the temperatures necessary for lubricating oil distillation. All of these light and low-boiling-point constituents serve to contaminate the lubricating oil cuts produced, so that when the required viscosity for a particular fraction is reached, the corresponding flash point is too low. As a result of this low flash point it becomes necessary to subject the resulting lubricating oil fraction to a reducing distillation step.

Some degree of success has been encountered in overcoming this low-flash-point trouble and in eliminating the necessity for reducing operations by employing fractional condensation equipment during the continuous distillation of lubricating oil stock. This fractional condensation equipment has been of the usual type long known to the art and the success of such operation has been not so much in the use of the fractional condensing equipment as in the fact that a relatively large number of distilling units arranged in a series have been used and substantially all of the gas oil and other light fractions removed in the first units of the series and before the oil reaches those units where the desired lubricating oil cuts are taken off.

In a distillation operation for the production of lubricating oil fractions, if, instead of employing a number of distilling units operated in series wherein the desired higher-boiling-point oils are vaporized separately, the entire composite lubricating oil stock, comprising the light, as well as the heavy constituents, be fed into a single distilling unit operated continuously and at a uniform or constant temperature, certain advantageous results from the distilling standpoint are obtained. It has been found that by such a distilling operation wherein the vapors from the higher boiling-point oils are evolved simultaneously and in a commingled state with the vapors of the lower-boiling-point oils, the temperature at which the higher boiling-point oils can be vaporized is materially reduced. When such distillation

is conducted continuously, and at a greatly reduced pressure and preferably with the use of steam, and the highest-boiling-point oils vaporized simultaneously with the vaporization of a material quantity of substantially lower-boiling-point oils, the temperature at which the highest-boiling-point oils may be vaporized is so reduced that decomposition of such oils by "cracking" is substantially prevented and a material increase in the production of the desired high-boiling-point and high-viscosity lubricating oil fractions made possible.

When these advantageous results are thus obtained, it will be evident that, due to the vapors of the high-boiling-point and low-boiling-point oils being evolved simultaneously and in a commingled state, subsequent separation of those low-boiling-point oils which lower the flash-point of the desired lubricating oils, together with a separation from each other of the different grades of lubricating oil cuts, becomes necessary. To merely condense these combined vapors without separation would be to produce a condensate unsuitable for treating and finishing as a lubricating oil.

The objects of this invention are to provide for a continuous distillation of the oil to be treated in a single unit under a reduced pressure less than atmospheric, (either with or without steam,) and at a substantially uniform and constant temperature, the vapors of the lower-boiling-point oils being vaporized simultaneously with the vaporization of the higher-boiling-point oils, so that the vapors of the lower-boiling-point oils assist by their influence the vaporization of the higher-boiling-point oils, thus carrying on the distillation at a temperature much lower than the vaporizing temperature of such higher-boiling-point oils, withdrawing the intermingled vapors as evolved, and by fractional condensation separating these commingled withdrawn vapors into respective distillates of the desired boiling-point range so that a furthr reducing distillation of respective distillates is not required before such distillate may be treated and finished as a lubricating oil.

The invention may be better understood and comprehended in its various aspects in connection with a description of a process comprising a preferred embodiment of the invention and by reference to the accompanying drawings which illustrate an apparatus in which may be performed a process comprising a preferred embodiment of my invention. The indicated apparatus is given for illustrative purposes only, and it is to be understood that the arrangement shown and the details of construction illustrated may be widely varied without departing from the scope of my invention.

In the drawings:

In Fig. 1 I have indicated an apparatus by means of which a process embodying my invention may be performed. In the apparatus as described in this figure, I have illustrated means for pre-heating the oil to be heated so as to materially increase the rate of evolution of the commingled vapors, giving an increased yield for the same charging rate or for the same yield, permitting an increased charging rate.

In Fig. 2 I have illustrated an apparatus of simpler form omitting the step of high pre-heating of the oil to be treated before its introduction into the vaporizing still.

Fig. 3 illustrates a form of fractionating condenser which may be employed.

Fig. 4 illustrates a re-heating fractional condenser which may be employed as a part of the apparatus.

Referring to Fig. 1:

2 represents a storage tank or source of supply. 3 represents the feed-line of the system in which is a suitable pump 4 for supplying the oil to be distilled through the feed-line 3 under suitable pressure and by which the desired velocity of flow is maintained. The feed-line 3 passes through a vapor heat exchanger 5, of ordinary or any preferred construction, and thence passes through a residuum heat exchanger 6, of ordinary or any preferred construction, and thence through the heating coil 7. This heating coil is mounted in a suitable furnace 8 and heated by suitable means, such as for example a burner 9. From this heating coil 7 the heated oil passes to a still or vaporizing chamber 10. In line between the coil and the outlet into the vaporizing chamber 10, I interpose a suitable pressure controlling valve 12, which may be set to maintain such pressure as may be desired or required. The form, shape or design of the still or evaporating chamber 10 may be varied as desired, and its form or shape or construction forms no part of the present invention. As shown, this still or evaporator 10 is mounted over a suitable furnace 13 provided with heating means, such as a burner 14. In practice, the evaporator may be heat-insulated to prevent radiation losses. 15 represents the vapor outlet line which passes from the evaporator 10 through the vapor heat exchanger 5 and thence to the inlet chamber 30 of the reheating fractional condenser 31. From this inlet chamber 30 the vapors pass through the tubes 32 into the outlet chamber 33 and thence by the pipe 34 to a second fractional condenser 35. This fractional condenser 35 may be of the form and construction illustrated in Fig. 3. After circulating through the chamber of the condenser 35, the uncondensed vapors pass through the outlet pipe 36 and into a second fractional condenser 37. This fractional condenser 37

may be of the ordinary or any preferred construction, such for instance as the fractional condenser of Fig. 3. 38 represents the vapor outlet pipe from the fractional condenser 37. This outlet pipe leads into the condensing chamber 39 of the re-heating fractional condenser 31, above the upper pipe or tube 32. Within this chamber 39 are mounted a series of pans 40 preferably circular in cross-section and suitably mounted in the condenser 31, as by suitable brackets or straps (not shown) welded to the inner shell of the condenser 31. Between adjoining pans 40 are interposed horizontal partitions 41 welded to the inner surface of the shell 31. These shells are provided at their centers with flanged openings as shown, of less size or diameter than the size or diameter of the pans 40. The rising vapors from the inlet pipe 38 are thus caused to pass through a curtain of descending condensate dropping from the lower partition 41 to the lower pan 40 and through successive curtains of descending condensate in passing around successive pans and up through the openings in successive partitions 41 and into the vapor-line 42. This vapor-line 42 is connected with a final fractional condenser 43, from which condenser the lightest distillate produced is withdrawn. 44 indicates the pipe or line by which the said distillate is withdrawn from the condenser 43. This pipe or conduit 44 is connected to a suitable storage tank (not shown) passing first through a suitable cooling coil 45 (see Fig. 2) in a suitable cooler 46 and thence through lock-boxes 47 and a receiving drum 48. This receiving drum is connected by a suitable line with a distillate storage tank E, a suitable suction-pump 49 being interposed in this line. The receiving drum 48 is connected by a suitable line 21 with the vacuum pump 20. 22 (Fig. 2) represents the exhaust from the vacuum pump. As this latter and apparatus and connections as shown in Fig. 2 may be readily connected to and used in the apparatus indicated in Fig. 1, I have not deemed it necessary to extend and show the same in Fig. 1. 50, 51, 52 indicate respectively the conduits or lines leading from the lower portions of the condensing chambers of the condensers 37, 35, 31, respectively. These respective conduit lines 50, 51, 52 are connected (as indicated in Fig. 2) through suitable cooling coils 45 in coolers 46 and thence through suitable lock-boxes 47 to receiving drums 48 and thence to distillate storage tanks or drums C, B, D, respectively. Each of the receiving drums is connected with the vacuum pump 20. 53 represents a condensate line leading from the chamber 33 of the condenser 31 and is in turn connected through a suitable cooling coil 45 in a cooler 46, through a suitable lock-box 47 and to a suitable receiving drum 17 and thence through a distillate pump and line to a distillate storage tank A. 54 represents a cooling medium supplying conduit connected with a suitable source of supply (not shown). This cooling medium is preferably water. As indicated in both Fig. 1 and Fig. 2, the direct line of this conduit 54 is through the valve 55, coil 56 in the chamber 39 of the re-heating fractional condenser 31, and thence back to discharge. A branch line 57 leads through a valve 58 into the condenser 43, passing downward through the tubes or pipes 59 thereof and out through the conduit 60 into the return leg of the line 54. 61 represents a valve in this line. The inlet portion of the line 54 is connected just beyond the branch 57 with a branch line 62 which communicates into the discharge conduit 60 below the condenser 43. 63 represents a suitable valve in this line. From the feed-line 3 leads a branch pipe 64, by means of which the relatively cool oil to be treated may be used as a cooling medium for the condensers 35, 37. By using such feed-oil as a cooling medium in such condensing operation, heat economy is effected and the feed-oil after passing through the condenser 37 and thence the condenser 35, is returned to the line 3, at raised temperature, by the return leg 65 of such conduit. 66 and 67 represent suitable valves controlling this conduit. The branch conduit 64 is connected directly with the condenser 37, and the feed-oil, after passing downward through the tubes thereof, passes into the return leg 65 through the pipe 68. A branch 69 leads from the line 64 to the condenser 35, and the condenser 35 is connected at its bottom by a pipe 70 with the return leg 65. 71 represents a branch pipe or conduit connected with the line 64 between the branch 69 thereof and the condenser 37. This branch line 71 is connected with the outlet line 68 of the condenser 37. 72, 73, 74, 75, 76 and 77 indicate suitable valves by which the flow of cooling medium through this cooling system may be controlled and regulated as desired. 78 indicates a valve interposed in the line 3 between the branch 64 and the return leg 65 thereof so that by suitable regulation of the valves 66, 67, 78, the circulation of feed-oil for this cooling system may be controlled and directed. 27 represents a steam line leading into the still or evaporating chamber 10, the end 28 of such steam-line being preferably in the form of a perforated pipe located near the bottom of the evaporating chamber. 29 indicates a valve controlling such steam-line. The steam-line 27 is connected to a suitable source of steam supply (not shown). 23 represents a residuum draw-off line which passes through the residuum heat exchanger 6 and through a cooler 25 to the residuum storage 26. If desired, the oil to be treated may be discharged into a suitable evaporat-

ing pan 11 in the upper portion of the still or evaporating chamber 10. 84 indicates a steam-line or source of supply by which, if desired, steam may be introduced into the condensing chamber 39 of the re-heating condenser 31. This steam-line 84 is connected with any suitable source of steam supply (not shown).

Referring to Fig. 2: The apparatus as illustrated in this figure of the drawings is in all essentials similiar to that illustrated in Fig. 1, except that the apparatus and connections for high fire pre-heating of the feed-oil are omitted. I have, therefore, in these two figures of the drawings used the same reference numerals as indicating corresponding parts. In Fig. 2 the oil-cooling and pre-heating branch line 64 is shown as provided with a branch-line 79 connecting to the feed-line 3 beyond the residuum heat exchanger 6, and the return leg 65 is shown as provided with a branch line 80 connected with the feed-line 3 beyond the residuum heat exchanger 6. A valve 81 is interposed in the feed-line 3 between the connections of the lines 79 and 80 therewith, and the lines 79 and 80 are respectively provided with valves 82, 83. The oil to be treated, after passing through the feed-line 3 and residuum heat exchanger 6, may by means of regulation of the valves 81, 82, 83, be passed into the cooling branch line 64 and back into the line 3 by the return leg 80, thus utilizing the partially heated oil when so desired.

In the preferred embodiment of my invention in a process of distilling the composite basic stock containing all the different lubricating oil fractions to produce lubricating distillates ready for treating and finishing as lubricating oils, the first step is the preheating of such stock to be treated to a much higher degree than can economically be obtained by the use of heat exchangers by which the waste heat of the system is utilized, i. e.; at temperatures below 400° F. I have found that a material increase in the rate of evolution of the commingled vapors from this composite stock is obtained, giving an increased yield for the same charging rate or for the same yield, permitting an increased charging rate, when the stock fed into the distilling chamber is pre-heated to temperatures higher than can economically be obtained by the use of such waste heat exchangers, i. e.: when such stock is heated to above 400° F. This pre-heating of such stock may be extended up to 800° F., and is conducted at pressures higher than those under which distillation takes place, after which the heated oil may be injected into a vaporizing chamber held at pressures less than atmospheric. This pre-heating may or may not be carried on in the presence of steam or water vapor, the vaporizing chamber may or may not be supplied with additional heat after the highly pre-heated oil is injected therein, and the vaporization may or may not be carried on in the presence of steam. I, therefore, pass the body of oil to be distilled through the heating element 7 in relatively small streams and maintain as high a velocity of the oil passing therethrough as is consistent with the heat transfer from such heating element to the oil and the mechanical conditions and adaptations of the particular apparatus and discharge the heated oil into the vaporizing chamber as quickly as possible after it has been raised to such temperature. I maintain such a pressure of the evolved vapors in the heating coil and conduit to the vaporizing chamber as may be required under the conditions of operation to substantially maintain the oil as it is being heated, and when heated, substantially all in liquid phase. Vaporization of such heated oil is effected in a single vaporizing chamber under a reduced pressure less than atmospheric. Under certain conditions of operation I have distilled oil in accordance with my process with as high as 26 inches of vacuum in the vaporizing chamber.

In a modification of my preferred process, the oil, instead of being heated in the heating element to the highest degree of temperature utilized in the distilling operation, may be heated only approximately thereto and a reasonable rise in temperature of the body of the oil effected in the vaporizing chamber by the application of exterior heat, as by means of a burner 14, and either with or without the use of steam therein. However, in such a modification and embodiment of my invention, the body of oil heated in the heating element is raised to such a temperature that it may be brought to the highest temperature of the distilling operation without the necessity of such a heat transfer in the evaporating chamber as will cause material "cracking" of any portions of the oil therein. Where in the heating element 7 the temperature of the oil to be distilled is raised above the "cracking" temperature of portions thereof, the oil being maintained substantially all in liquid phase therein by maintaining suitable pressure thereon, the oil is quickly discharged, after reaching the desired temperature, into the vacuum vaporizing chamber 10 so that the heated oil is not subjected to such "cracking" temperature for a sufficient time to permit of the "cracking" reaction. In such case, if the insulation of the vaporizing chamber 10 is sufficient, it may not be necessary to supply any exterior heat whatever to the vaporizing chamber to vaporize the desired fractions. Heat may be supplied to such vaporizing chamber 10 by means of external heat, as, for example, the furnace 13 and burner 14, to impart to the oil loss of heat by radiation or evaporization or to impart additional heat so long as the heat de-

mand upon the shell of the evaporating chamber is not sufficient to cause substantial "cracking" of portions of the oil undergoing distillation. With such fired pre-heating of the oil, where using certain California oils, I have found by raising such oil in the heating element to the temperature of 750°–800° F.; and retaining the same in liquid phase, immediately injecting such heated oil into a vaporizing chamber under vacuum, vaporization of the desired fractions of the oil takes place without "cracking." If, however, it is desired to vaporize a higher-boiling-point or more viscous fraction of fractions, some additional heating may be required in the vaporizing chamber. Without such additional heat supply in the vaporizing chamber, the resultant liquid oil may be maintained therein at substantially 630° F. Temperatures even above 630° F. have been thus attained in the liquid body in such vaporizing chamber. If only the heat lost by radiation is supplied to the vaporizing chamber, this temperature of the oil in the vaporizing chamber is held uniform, i. e., there is no differential temperature between the body of such oil and the shell of the vaporizing chamber. Furthermore, by applying additional heat to the vaporizing chamber in any degree less than sufficient to cause "cracking" or decomposition at the contact between the shell of the vaporizing chamber and the oil therein, a still higher temperature may be maintained in such oil body. By thus delivering the oil to be distilled into the vaporizing chamber at such increased temperature, I am able to attain a marked increase in the charging rate and, therefore, an increased capacity for the production of high-boiling-point and high-viscosity oils. Also I am able to cut deeper and produce more high-boiling-point and high-viscosity oil from a given stock. In certain runs the rate of charging must be properly proportioned to permit the vaporization of such higher-boiling-point and higher-viscosity oil. The lubricating oil thus produced is of a marked superior quality. Aside from having a high boiling point and a higher viscosity, due to higher temperatures and deeper cuts employed, I produce a higher-viscosity oil due to the absence of "cracking" compounds. A better color is also maintained and the treating loss will be found to be reduced.

If, however, it be not desired to utilize this feature of high-fired pre-heat and maintaining the oil in liquid phase by pressure during such pre-heat and the immediate discharge of the highly pre-heated oil into the vacuum chamber before "cracking" takes place, I have found that the oil can be subjected to a progressively increasing heat, materially higher than that obtained by the use of waste heat exchangers, but to a lower temperature than that obtainable in the heating element 7 as heretofore set forth. For example, utilization of the waste heat of the operation cannot economically be utilized to raise the oil to be distilled to above 400° F. Additional heat may be supplied to the oil by means of the heating element 7 to raise the temperature thereof to any desired degree below the "cracking" temperature of any appreciable portion thereof, and if such temperature is not sufficient or the vaporization of the desired high-boiling-point, high-viscosity fractions desired to be distilled, the required additional heat can then be supplied in the vaporizing chamber without danger of "cracking," inasmuch as the temperature of the oil has been raised to such an approximation of the temperature of the desired distilling operation that the heat differential between the body of oil to be distilled as injected into such vaporizing chamber and the shell temperature required for the required heat transfer from the vaporizer 10 to the oil is not sufficient to cause such an abrupt and excessive raise in the temperature of the oil particles in contact with the heated metallic surface as will cause "cracking" thereof. I am, therefore, in this modified embodiment of this pre-heating step of my invention, able to conduct such distilling operation at a higher temperature without "cracking" than has heretofore been possible. Increased capacity, increased charging rate, or deeper cut, is thus rendered possible.

It is obvious that this highly pre-heated oil may be injected into the vacuum vaporizing chamber either above or into the liquid therein. If desired, such oil may be injected onto a spreading-pan, as indicated at 11 in the drawings, or other spreading or distributing means.

From the foregoing it is seen that this step of high-fired pre-heating of the stock to be distilled comprehends in its several aspects the continuous distillation at a pressure below atmospheric, by first heating such oil to be distilled at a pressure higher than that under which distillation takes place, such heating being effected either with or without the presence of water vapors or steam and to a temperature higher than can be economically obtained by the use of heat exchangers utilizing the waste heat of the system, i. e.; to temperatures between 400° F. and 800° F., injecting such heated oil into a chamber maintained at a pressure less than atmospheric, which chamber may or may not be supplied with additional heat, depending upon the degree to which the oil has been heated before interjection therein, and in which chamber additional steam may or may not be injected, as preferred, the manner of injecting the highly heated oil into the vacuum vaporizing chamber being preferably above the surface of the liquid therein in such a manner as to expose the maximum vaporization surface to facilitate distillation, al-

though if desired such injection may be below the surface of the liquid therein. Also the step comprehends a continuous feed, a continuous vaporization and continuous withdrawal of the evolved vapors, and the withdrawal of the residual unvaporized product either continuously or intermittently, as desired.

Preferably, all of the vapors to be distilled from the stock are vaporized and pass off the oil together. The mixture of relatively higher and relatively lower-boiling-point oils all vaporized simultaneously will be found to have the effect of vaporizing relatively higher-boiling-point fractions than would be vaporized at the given temperatures were such higher-boiling-point fractions vaporized alone after the vaporization of such relatively lower-boiling-point fractions. All of such vapors are withdrawn from the vaporizing chamber intermingled and pass to the condensing apparatus.

The next step of my invention is to separate and segregate the intermingled relatively lower-boiling-point and relatively higher-boiling-point oils contained in the intermingled vapors withdrawn from the vaporizing chamber. It is highly advantageous to effect this separation in such manner and under such conditions that the produced condensates will be distillates of the desired boiling points and viscosities and not require rerunning or reducing to provide a stock ready for treating and finishing as lubricating oil; also to remove from the respective distillates those lighter and lower-boiling-point constituents which serve to contaminate the distillates produced by lowering the flash-point thereof.

In the preferred embodiment of a process embodying my invention, therefore, I prefer to utilize the high heat of the intermingled vapors as withdrawn from the vaporizing chamber as a means for re-heating the condensate of the relatively lower-boiling-point oils. I, therefore, pass these intermingled vapors through closed conduits contained within a chamber, to which chamber is returned the vapors of the lighter or lower-boiling-point fractions, said returned vapors being brought to a lower temperature by a controllable cooling means located within said chamber whereby a reflux results from said returned vapors, and re-heating this reflux through the means of the heat of the total intermingled evolved vapors passing from the evaporating chamber or still through said passages of said chamber, thereby revaporizing and separating from such reflux those light fractions which are low in flash-point. This step of the process may be more readily understood in connection with the detailed explanation of such preferred embodiment. I will, therefore, trace the course of passage of the withdrawn intermingled vapors of the distilling operation through the steps of condensation and segregation. The highly heated vapors first pass into the chamber 30 of the re-heating fractional condenser 31 and pass through the tubes 32 thereof into the chamber 33. The descending condensate from the upper chamber 39 contacts with the tubes 32 highly heated by the passage of the vapors therethrough, and this condensate or reflux is thus re-heated and those light fractions which are low in flash-point are revaporized and the resulting condensate from which they are separated is withdrawn through the pipe or conduit 52 to the distillate storage tank D. The effect of this heat transfer is to cause a certain condensation of the highest-boiling-point vapors in the chamber 33. This condensate is drawn off from the chamber 33 by the pipe 53 to the storage tank A. The vapors passing from the chamber 33 through the conduit 34 and into the condenser 35 are further cooled therein and the condensate forming therein is withdrawn through the pipe 51 to the distillate storage tank B. The vapors passing from the condenser 35 through the pipe 36 to the condenser 37 are further condensed in the latter and the condensate therein formed drawn by the pipe 50 into the distillate storage tank C. The vapors ascending from this condenser 37 pass by the vapor conduit 38 into the chamber 39 of the re-heating fractional condenser 31, wherein they are partially condensed, the condensate subjected to re-heating as before described, and the vapors pass out through the vapor-line 42 and into the final condenser 43, the condensate of which is drawn by the pipe 44 into the storage tank E. From the foregoing description, it will readily be seen that by this controllable fractional condensation of the intermingled vapors of distillation I am able to produce distillates of the desired boiling point range substantially free from low-flash-point oil, and that each of these distillates is completely distilled and forms an oil ready for treatment and finishing as a lubricating oil. Re-running or reducing is obviated.

While in the preferred process forming a preferred embodiment of my invention I prefer to utilize the relatively cold fresh feed of the oil to be distilled as the cooling medium for the condensers, (such as condensers 35, 37,) of the intermediate distillates, and to use water circulation as the cooling medium for controlled regulation of the condensation in the initial or final condensers, it is obvious that any controllable cooling medium may be used for these purposes, and the invention is not necessarily limited to the use of either water or of the fresh feed stock as the cooling medium.

I claim:

1. The process of separating petroleum vapors, which comprises passing such vapors at a temperature below that at which por-

tions of the vapors would crack or decompose through closed passages contained within a chamber, thence through chambers held at successively lowered temperatures and in which condensates of successively lower boiling points are condensed from the vapors, separately withdrawing such condensates, returning the residue vapors from these chambers to the first mentioned chamber, wherein reflux of the heavier fractions of the returned vapors is obtained by a cooling means and in which chamber this reflux is reheated and partially revaporized by heat supplied by the total and initial vapors, withdrawing the residue reflux remaining from said revaporization, and separately withdrawing the condensate which forms in the closed vapor passages through which the total and initial vapors pass.

2. The process of the separation of petroleum vapors, which comprises passing the vapors at a temperature below that at which portions thereof would crack or decompose through closed passages contained within a chamber, thence through chambers held at successively lower temperatures and in which condensates of successively lower boiling points are condensed from the vapors, separately withdrawing said condensates, returning the residue vapors from these chambers to the first mentioned chamber wherein these vapors are brought to a lower temperature by controllable cooling means, thus producing a reflux of the higher boiling point constituents of the returned vapors, subjecting such reflux to a higher temperature through the means of the total and initial vapors, withdrawing the residue reflux remaining from said revaporization, and separately withdrawing the condensate which forms in the closed vapor passages through which the total and initial vapors pass.

3. A process of separating mixed petroleum vapors, which includes passing all of such vapors, at a temperature below that at which portions thereof would crack or decompose, through closed transverse passages contained within a chamber, withdrawing and returning a part of said vapors to said chamber, wherein reflux of the heavier fractions of the returned vapors is obtained by a cooling means, and in which chamber this reflux is reheated and partially revaporized by heat supplied by the first said petroleum vapors but out of contact therewith, and withdrawing the residue reflux remaining from said revaporization.

4. A process of separating mixed petroleum vapors, which includes passing such vapors at a temperature below that at which portions thereof would crack or decompose through closed transverse passages contained within a chamber, withdrawing and returning a part of said vapors to said chamber, wherein reflux of the heavier fractions of the returned vapors is obtained by a cooling means, and in which chamber this reflux is reheated and partially revaporized by heat supplied by the first said petroleum vapors but out of contact therewith, and withdrawing the residue reflux and separately withdrawing the condensate which forms in the closed vapor passages through which the total vapors pass.

5. A process of separating petroleum vapors, which comprises passing such vapors at a temperature below that at which portions of the vapors would crack or decompose through closed passages contained within a reflux condenser chamber in which passages partial condensation takes place, withdrawing the condensate formed during the passage of said vapors through said closed passages, subjecting the remaining vapors to partial condensation in a separate chamber from which the condensate is withdrawn, returning the uncondensed vapors therefrom to said reflux condenser chamber wherein such vapors are subjected to further reflux condensation and the reflux obtained thereby is reheated and the low boiling point constituents of such reflux revaporized by the heat supplied by the passage therethrough of the original vapors, withdrawing the residual reflux remaining after said revaporization, and passing the vapors from said chamber to a condenser.

Signed at Richmond, California, this 28th day of Sept., 1923.

RICHARD W. HANNA.