Oct. 8, 1940. J. E. SCHULZE 2,217,386

APPARATUS FOR DISTILLING MINERAL OILS

Original Filed May 5, 1932 2 Sheets-Sheet 1

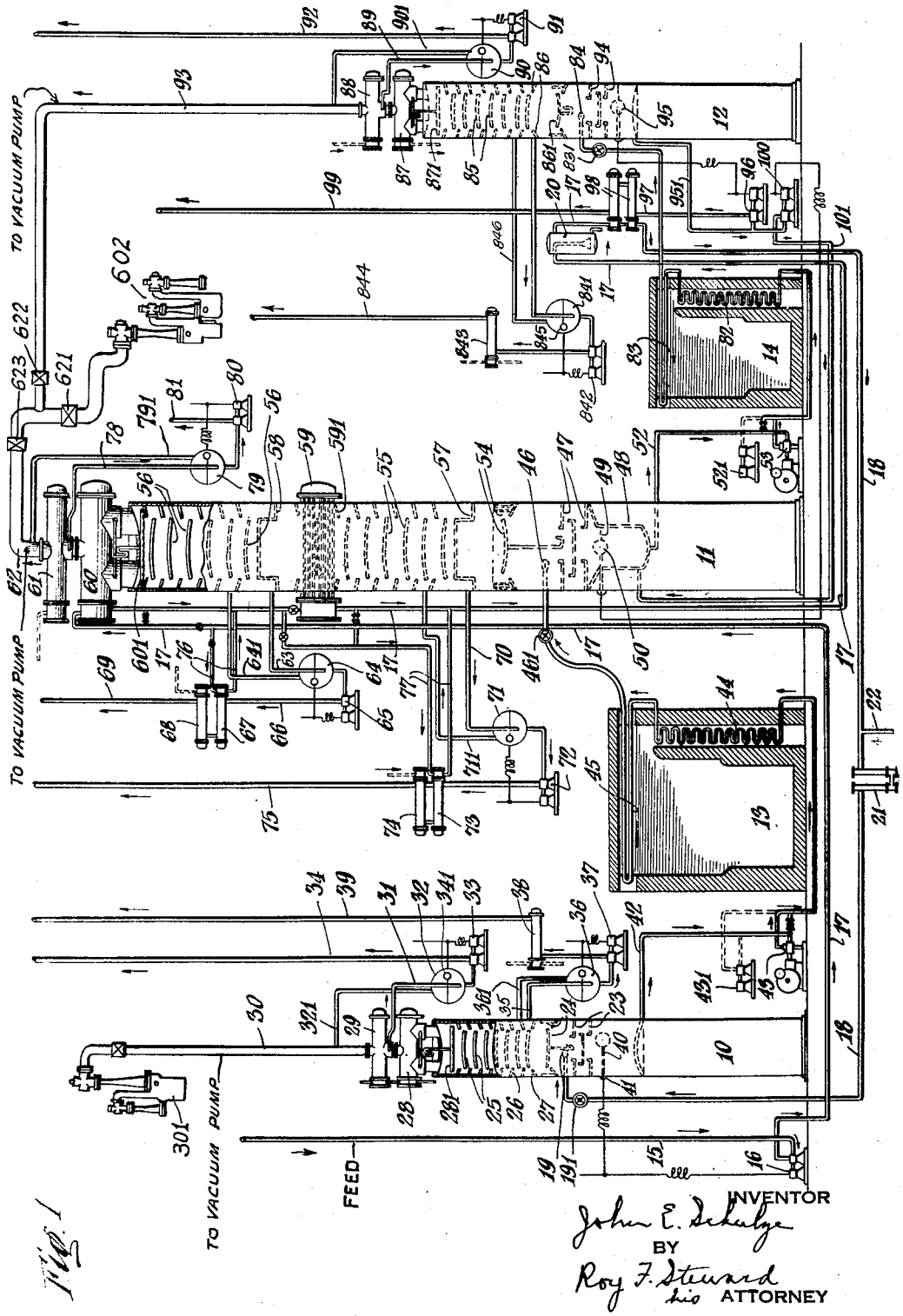


Fig. 1

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Original Filed May 5, 1932 2 Sheets-Sheet 2

Fig. 3.

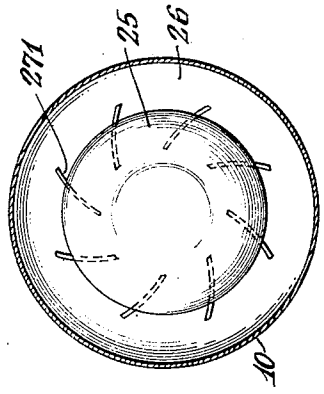


Fig. 3a.

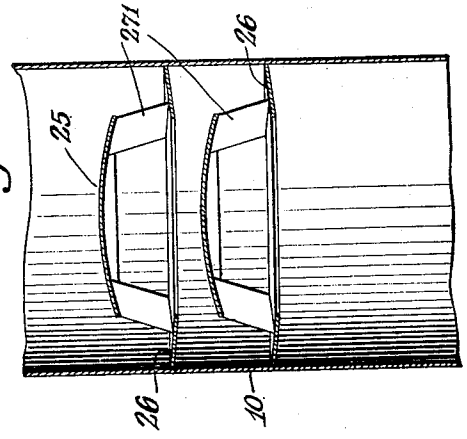


Fig. 2.

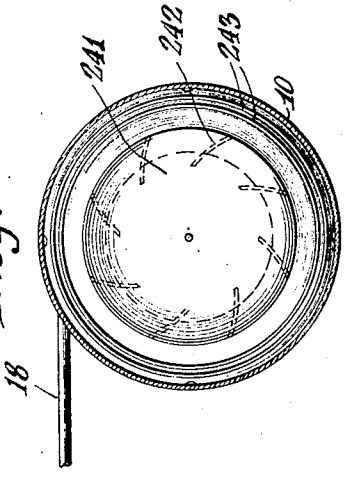
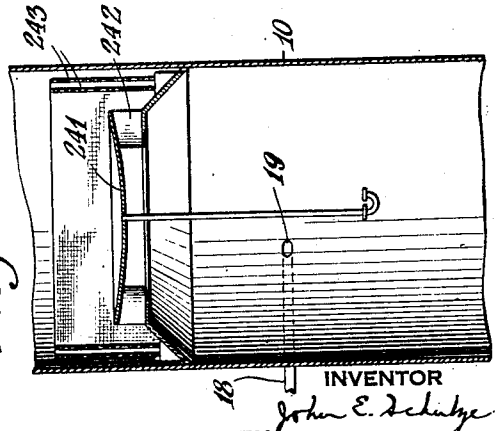


Fig. 2a.



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2,217,386

APPARATUS FOR DISTILLING MINERAL OILS

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Original application May 5, 1932, Serial No. 609,508. Divided and this application June 4, 1937, Serial No. 146,494

4 Claims. (Cl. 196—114)

This invention relates to apparatus for distilling mineral oils; and it relates more particularly to apparatus for the manufacture of lubricating oils by distillation of suitable mineral oil charging stocks under very high vacuum, that is, under very low absolute pressure.

The apparatus of the invention is disclosed in prior copending application Serial No. 609,508, filed May 5, 1932, Patent No. 2,088,616, granted August 3, 1937, of which the present application is a division.

A general object of the invention is to provide a distillation apparatus system of improved type for the manufacture of mineral lubricating oils as overhead distillates under low absolute pressure and more economically than has heretofore been possible, of stable lubricating oil distillates requiring no acid treatment or filtration to render them marketable as finished high grade lubricating oils of good color and stability.

A further object of the invention is to accomplish this objective by providing a novel apparatus system in which not only the general combination but also the component apparatus units shall possess novel features of construction and operation.

With this general object in view, as well as others which will become apparent hereinafter, the invention comprises the novel apparatus parts and combinations thereof which will first be described in connection with a typical illustrative embodiment within the scope of the invention, and will then be more particularly pointed out in the claims.

Although the novel apparatus system may be employed to advantage in various connections, it is particularly useful in separating lubricating oil components from mineral oil charging stock by flash-vaporization under low absolute pressure, as described in Patent No. 2,088,616 aforesaid. As therein set forth, a relatively quick separation of lubricating oil components from the heavier components of a given crude mineral oil material or charging stock is effected by a continuous procedure which includes rapidly heating the crude material to temperatures sufficiently high to vaporize all the desired lubricating oil components under absolute pressure on the order of 50 millimeters of mercury or lower, vaporizing such components at such low absolute pressure, and condensing them under such low pressure as one or more lubricating oil distillates substantially free of tarry and other heavier constitutents of the crude starting material employed, as well as from nearly all of the lighter constituents thereof.

By proceeding in the manner above described, a number of highly important advantages are realized. Separation of the heavier and more heat-sensitive constituents of the crude charging stock from the lubricating oil constituents being accomplished quickly, the objectionable long continued heating of the heavier constituents necessarily involved in batch distillation of the crude charging stock is avoided. It is true that such quick separation requires heating the crude charging stock to temperatures as high as, say, 725° F., or higher than can be employed under any conditions without some breaking down or cracking of the heavier oil components, including some of the heavy lubricating oil components; but the time factor is so greatly reduced that the loss of lubricants from cracking is relatively slight.

In the typical distillation system hereinafter more particularly illustrated and referred to by way of concrete example as embodying the principles of the invention, the crude charging material may be heated to the necessary temperature and passed through a series of flash vaporizers to distil off whatever gas oil or other non-viscous fractions the material may contain, and also to distil off the desired lubricating oil fractions from the lightest and least viscous to the heaviest and most viscous; leaving unvaporized, as flux oil (e. g.), a tarry residue of heavier components of the crude charging stock. The vapors produced in each vaporizer may be passed upwardly through a fractionating tower or column constructed and adapted to minimize "vacuum drop" through the tower (increase in absolute pressure from the top toward the bottom) as much as possible. Whatever liquid residual material remains unvaporized in any given flash vaporizer is passed into the next succeeding vaporizer for re-flashing, ordinarily after being heated to a higher temperature, to vaporize such further lubricating components as can be thus obtained therefrom.

An important specific feature of the invention, essential for minimizing "vacuum drop" as aforesaid, resides in the employment of fractionating means functioning effectively and yet with relatively very small resistance to passage of the vapors which, under the conditions characterizing the high vacuum distillation here involved, travel at very high velocity. In particular, it is desirable to give the oil vapors a whirling move-

ment in contact with counterflowing reflux in a manner to be hereinafter described.

In order to explain further the underlying principles of the invention, a detailed description will now be given of a typical embodiment of the new apparatus which has been found particularly advantageous in practice. It is to be understood, however, that the details hereinafter given are merely for the purpose of illustrating one practical form of the invention, and that the invention is not in any sense restricted to the specific details here illustrated by way of a concrete explanatory example.

The accompanying drawings illustrate more or less diagrammatically, and to some extent in the form of a flow sheet, a typical distillation plant embodying this invention. In these drawings,

Fig. 1 illustrates the primary distillation unit of the system, showing the principal apparatus or equipment parts in side elevation, parts being broken away and in section to disclose certain structural details; and

Figs. 2, 2ª, 3 and 3ª are views of certain parts in greater detail.

The distillation unit or system (Fig. 1), in the specific form here illustrated, is adapted and arranged for continuous distillation of mineral oil charging stock by a succession of flash vaporizations whereby all the lubricating oil components of the charging stock, from very light to extra heavy, together with any ligher fractions, such as gas oil, which the charging stock may contain, are continuously vaporized at low absolute pressures, the resultant vapors being fractionated to separate the lubricating values in several cuts or fractions, as may be desired, and also to obtain the gas oil mainly as another cut or cuts separate from the lube cuts, while rapidly withdrawing from the various condensed lube distillates uncondensed vapors and gases including a substantial proportion of whatever malodorous and other contaminating matters may be present. Some of these contaminants may be condensed with one or more gas oil cuts.

As here illustrated, the distillation unit comprises towers 10, 11 and 12, together with pipe still 13 cooperating with tower 11, and pipe still 14 cooperating with tower 12. In the present example, the apparatus system illustrated is adapted to handle crude charging stock, such as a topped crude petroleum containing little or no material more volatile than gas oil. The distillation and quick separation of lubricating constitutents proper from such charging stock is preceded by an initial flashing-off in tower 10 of some of the gas oil and such small amount of lighter constituents as may be present in the charging stock. The heat for this initial flashing off may be obtained through recovery of heat from a later stage of the flash-vaporizing procedure carried out in a succeeding tower. The crude charging stock is drawn through supply line 15 by pump 16, and after being sent through line 17 to certain heat exchange means (67, 73, 98) and being heated to around 375°–400° F., as will hereinafter appear, it is returned through line 18 and is discharged by the pump into tower 10 as indicated at 19. Where the crude charging stock contains salt water, as is often the case, this should be removed by passing the stock through a dehydrator 20 interposed at a point in line 17 where the stock has attained a temperature of, say, 300° F. In return line 18 is interposed a mixing coil 21 where a suitable quantity of caustic soda solution may be thoroughly mixed with a flowing stream of preheated charging stock, the caustic soda solution being introduced into the line through pipe 22 which enters the line in advance of the mixing coil 21. The preheated charging stock is delivered tangentially into tower 10 at a point slightly above the stripping plates 23 contained in the lower part of the tower. Just above the point of charging stock delivery or inlet is an entrainment separator 24 so designed as to impart considerable velocity and centrifugal action to the vapor ascending the tower, with a minimum drop in vacuum, to throw out any liquid particles entrained with the vapor, thus permitting a clean separation of such particles from the vapor prior to entering the fractionating zone located above the entrainment separator. The construction of the entrainment separator is shown in greater detail in Figs. 2 and 2ª. The vapors rising to plate 241 are deflected laterally by curved vanes 242 which direct the vapors against screen 243 while the vapors are also given a whirling movement. Entrained liquid particles arrested by the screen drain downwardly along the walls of the column.

In the fractionating zone are provided a plurality of suitable fractionating plates 25 cooperating with downwardly sloping side rings 26. The lowest of these plates has a cooperating side ring 27 which slopes upwardly, the combination constituting a collecting plate. Curved guide vanes 271 (Figs. 3 and 3a) serve to impart whirling movement to the ascending vapors. The higher boiling portions of the ascending vapors, which consist mainly of gas oil, are condensed in reflux condenser 28, the liquid reflux condensate being discharged through distributor head 281 at the top of the column and flowing down over the fractionating plates, of which there are eight in the present example, in intimate contact with the ascending vapor. While the plates are so designed as to give intimate contact of counterflowing reflux and vapor they are of such character as to cause minimum vacuum drop in the column. This type of plate or tray has been found to be particularly suitable and to be far superior for this purpose to bubble plates, the use of which has heretofore been attempted in lubricating oil distillation but has been far from satisfactory. Other specific designs of plate can of course be employed within the broad scope of the invention.

Gases, lighter vapors and water vapor escaping condensation in the reflux condenser 28 pass to a final condenser 29 where a still lighter gas oil is condensed together with some malodorous and unstabilizing constituents. The remaining uncondensed vapors and gases are swiftly sucked away through large-diameter offtake 30 by suitable exhausting means, such as a 2-stage vacuum pump of the ejector type, conveniently indicated at 301. The exhausting means is so operated as to maintain the entire interior of tower 10 under low absolute pressure. This absolute pressure should not exceed 50 millimeters of mercury as a maximum at any point in the column, and it is desirable in practice that this maximum should be substantially less than 50 millimeters, say 30 millimeters. Due to the resistance offered to the upward flow of vapors by the entrainment separator and fractionating plates, the absolute pressure at the point of initial vaporization, that is, at the point where the charging stock is delivered into the column, will be somewhat higher than the pressure at the top of the column. Where

plates of the character here illustrated are employed, however, this vacuum drop or pressure increase is reduced to a minimum and considerably below what is possible with a bubble-tray system of comparable fractionating effect. Thus, assuming that the absolute pressure at the point of vaporization is to be maintained at substantially 30 millimeters, this can be accomplished by operating the vacuum pump to maintain an absolute pressure of 25 millimeters at the top of tower 10 just before the vapors enter tne reflux condenser 28.

The light gas oil and malodorous fraction or cut condensed in the final condenser 29 is led away through line 31 to constant level seal tank 32, from which it is withdrawn by pump 33 and delivered through line 34 to storage. The seal tank has a pressure balancing connection 321 to vacuum line 30. Pump 33 is located a sufficient distance below the seal tank to give the necessary suction head, and the rate of operation of the pump is automatically controlled in a wellknown manner by appropriate connections to float 341 in the seal tank to maintain the liquid level in the seal tank constant.

The higher boiling gas oil fraction caught by collecting plate 27 is taken from the tower through line 35 to seal tank 36, from which it is withdrawn by pump 37 and pumped through cooler 38 and thence through line 39 to storage, the operation of the pump 37 being automatically controlled, by means similar to that already described for pump 33, to maintain a constant level of the liquid distillate collecting in seal tank 36. The seal tank is provided with pressure balancing connection 361 to a point in the column at least one plate higher than where line 35 leaves it or, of course, this balancing connection may go to the vacuum line (e. g. 30).

That portion of the charging stock which does not vaporize upon delivery into tower 10 passes down over stripping plates 23 and accumulates in the base of the tower to the level indicated at 40, this level being maintained constant by float control mechanism 41 which controls the rate of operation of charging stock feed pump 16 through regulation of its steam supply, the arrangement being the same as described by pump 33 and seal tank 32. This unvaporized residue of liquid oil containing substantially all the original lubricating oil constituents of the raw charging stock, together with most of the gas oil, is next heated to a much higher temperature in order that a large part of the lubricating constituents may be flash-vaporized therefrom in tower 11 at still lower absolute pressures than those prevailing in tower 10. To this end, the residual oil is drawn from the base of the tower 10 through line 42 by pump 43 and forced through the convection and radiant tube banks 44, 45, of pipe still 13, where it is heated to the desired higher temperature and is discharged into tower 11 at 46, at which point a vaporizing pressure of, say, 12 millimeters absolute, is maintained. The pipe still heater is so designed that the oil passes through the heating tubes at high velocity (e. g. 6 to 8 feet per second) with extreme turbulence, whereby the danger of local overheating and cracking of the oil is eliminated. A slight pressure is maintained at the discharge end of the outlet of the pipe still into tower 11, by means of a valve 461, in order to minimize vaporization of oil in the tubes of the pipe still heater.

The lighter portions of the highly heated oil thus discharged into tower 11, including both gas oil and lubricating oil fractions, flash into vapor which ascends the column. Such portion as is not vaporized passes downwardly as a liquid over stripping plates 47 and collects in the constricted base 48 to a level 49 automatically controlled through the regulating action of float control 50 on the operation of a re-circulating supply pump 100, to be referred to again hereinafter, which augments and maintains constant the supply of hot liquid residue available for withdrawal through line 52 by pump 53.

In ascending tower 11, the oil vapors flashed off therein undergo fractionation by means generally similar to that already described for tower 10. In addition to an entrainment separator 54, there are provided two sets of fracionating plates 55, 56, with cooperating collector plates 57 and 58, respectively, and reflux condensers 59 and 60, respectively. This enables the lubricating oil components of the ascending vapors to be fractionated, condensed and withdrawn from the tower in two cuts or fractions, one comprising relatively light components corresponding generally to light lubricating oil, and the other comprising medium and heavy lubricating oil. Division of the lubricating oil condensate into this or any other specific number of fractions is a matter of choice and depends largely upon considerations of a practical nature unnecessary to discuss. Combining the two fractionating sections in a single tower, as here illustrated, is economical as to cost of construction and operation, but is not essential to the practice of the invention.

The vapors evolved at 46 pass upwardly through tower 11 with a whirling movement, as previously explained in connection with tower 10, in intimate contact with a moderately high-boiling lubricating oil reflux provided by condensation in reflux condenser 59 of the heavier lubricating oil fractions of the vapors, this reflux being directed to the topmost of the plates 55 largely by side ring 591 and filming down over the remaining plates of this lower series. Lower boiling lubricating oil vapors pass beyond condenser 59, whirling upwardly in contact with descending films of liquid lubricating oil reflux provided by condensation in condenser 60 of those lower-boiling lubricating constituents which escape condensation therebelow. This reflux is delivered to the topmost of plates 56 by circular distributor 601.

Vapors of gas oil and any other lighter products escape condensation in reflux condenser 60 and pass on into water-cooled final condenser 61, where the principal gas oil fraction is condensed, together with some malodorous and unstabilizing impurities. Residual uncondensed vapor and gases are drawn away at high rate of speed through large diameter offtake 62 by suitable exhausting means which, for this tower, may advantageously be a 3-stage vacuum pump of the ejector type, conventionally indicated at 602.

In a typical instance, the exhausting means just mentioned is operated at such rate as to maintain an absolute pressure of about 4 millimeters of mercury at the top of the column just below the reflux condenser 60. Under such conditions, employing the special low resistance type of fractionating plates hereinabove recommended, there is a vacuum drop or pressure increase of only about 8 millimeters down through both fractionating sections and the entrainment separator 54, the absolute pressure at the discharge inlet 46 being thus only about 12 millimeters, while the pressure immediately below the collecting plates

57 and 58 is approximately 11 millimeters and 7 millimeters, respectively. These figures are of course not to be understood as in any sense restrictive, although they are characteristic of good practice within the scope of the invention.

Condensed light lubricating oil distillate is led away from collecting plate 58 through line 63 to constant level seal tank 64, from which it is withdrawn by pump 65 and pumped through line 66, heat exchanger 67, water-cooled cooler 68, and line 69 to storage.

Similarly, medium-heavy lubricating distillate condensed in the lower fractionating section and collecting on plate 57 passes to storage by way of line 70, seal tank 71, pump 72, heat exchanger 73, water-cooled cooler 74 and line 75.

Pumps 65 and 72, like all other pumps in the system drawing liquid oil from a container maintained under high vacuum, are located a sufficient distance below their respective seal tanks 64 and 71 to ensure the necessary head of oil on their intakes for proper operation.

In a typical instance, the vapor temperatures in tower 11 may be approximately as follows: 560° F., just below collecting plate 57; 500° F. just below reflux condenser 59; 465° F. just below collecting plate 58; and 350° F. just below reflux condenser 60.

The reflux condensers 59 and 60 utilize as their cooling medium the charging stock which passes through the cooling spaces thereof prior to being delivered into tower 10. For this purpose, the crude charging stock line 17 is extended as shown on the drawing, the charging stock flowing therethrough and through the cooling spaces of the said reflux condensers in the directions indicated by the arrows. The cooling of the lubricating distillates in heat exchangers 67 and 73 is similarly effected by means of the initial charging stock to be preheated, branch piping 76 and 77, connected with charging stock line 17, being provided for said heat exchangers 67 and 73, respectively, to attain this end. Suitable valves (not shown) may be provided in the piping system to regulate and vary the distribution of the crude charging stock to the cooling spaces of the several heat exchangers and reflux condensers referred to.

The gas oil fraction condensed in condenser 61, which amounts in a typical instance to around 12 to 14 per cent of the crude charging stock, is led away to storage by way of line 78, seal tank 79, pump 80 and line 81, the arrangement and automatic operation of pump 80 being similar to that already described for the other similarly functioning pumps. This gas oil fraction also includes some malodorous and unstabilizing contaminants, as already stated.

The several seal tanks associated with tower 11 are provided with suitable pressure balancing connections 641, 711, 791, as shown.

Unvaporized liquid oil which may be at a temperature of around 600° F. in a typical instance, is drawn from the base of tower 11 by pump 53 and forced at high velocity and with turbulent flow through tube banks 82, 83, of pipe still 14, being thereby heated to a still higher temperature, which is the maximum used and which may be from 700° to 725° F. At this temperature, under slight pressure regulable by valve 831, it is discharged into tower 12 at point 84, and flash vaporization of the heaviest lubricating oil fractions obtainable as overhead distillates there takes place. The absolute pressure maintained at the flash vaporization point 84 in tower 12 should be the minimum for this location in any of the towers. A pressure of 6 millimeters absolute and vapor temperature of about 670° F. at this point in tower 12 is good practice, with a pressure of 3 millimeters and vapor temperature of 490° F. at the top of the column above the fractionating section comprising fractionating plates 85, collecting ring 86 and entrainment separator 861. The heavy lubricating oil vapors flashed off at 84, together with a very small percentage of lower boiling vapors which are practically all non-lubricants, pass upwardly through the system of fractionator plates 85 (eight in number in this instance) in intimate contact with down-flowing films of heavy lubricating oil vapors in reflux condenser 87 which may be water-cooled as here shown. Distributor 871 delivers this liquid reflux to the topmost of plates 85.

Reflux condenser 87 is so operated, through appropriate regulation of its cooling water, that a very small proportion of lubricating oil vapors escape condensation therein, and pass therefrom, together with residual uncondensed lighter vapors and gases, into final water-cooled condenser 88, where a small amount of condensate is formed and passes off through line 89 and thence by way of seal tank 90 automatically controlled pump 91 and line 92, to storage. Residual uncondensed vapors and gases are drawn away through large-diameter offtake 93 by suitable exhausting or vacuum-producing means, such as 3-stage ejector pump 602 aforesaid, the offtake connections of the columns 11 and 12 thereto being appropriately valved, e. g. as indicated at 621, 622 and 623. The condensate formed in condenser 88, which commonly amounts to around 0.5 per cent of the crude charging stock, comprises about equal proportions of lubricating oil and contaminants of malodorous and unstabilizing character. It is good practice to allow this small quantity of lubricating constituents to escape condensation in condenser 87 in order to ensure better separation of said contaminants from the heavy lubricating distillate drawn off from plate 86. This heavy lube distillate passes to storage by way of seal tank 841, pump 842, water-cooled cooler 843, and line 844; operation of the pump being controlled by constant-level control float device 845. Seal tanks 841 and 90 are provided, respectively, with pressure-balancing connections 846 and 901, as shown.

The unvaporized liquid residue of the oil charged into tower 12 constitutes the final residuum obtained from the primary distillation after all the recoverable lubricating values have been vaporized from the initial charging material. This final residuum, which may be in the nature of a flux oil, passes down over stripping plates 94 and accumulates in the base of tower 12 to a level maintained constant through suitable connections of a float control device 95 to flux oil pump 96 which draws flux oil, at a temperature of, say 650° F., from the base of tower 12 through line 951 at an automatically regulated rate and delivers it to storage by way of line 97, heat exchanger 98, and line 99. In heat exchanger 98, the extremely hot flux oil gives up a large part of its heat units to the initial crude charging stock which has already been preheated to a considerable extent by passage through reflux condensers and heat exchangers operated in conjunction with tower 11, as already described.

Associated with pipe still charging pumps 43 and 53, which may conveniently be electrically driven, are shown steam stand-by pumps 431 and

521, respectively, for alternative operation in cases of current supply failure.

In order to increase the efficiency of vaporization in tower 12 in effecting as complete removal as possible of lubricating values from material being processed, without at the same time increasing the temperature of the pipe still discharge into tower 12, a portion of the very hot flux oil collecting in the base of tower 12 may be re-circulated through pipe still 14. This may be effected in various ways, but a good practical method is that shown on the drawings wherein the portion of hot flux oil (e. g. at 650° F.) to be thus re-circulated is picked up by pump 100 and delivered through line 101 to sump 48 at the base of tower 11, the operation of the pump being automatically regulated as to rate by liquid level control device 50 suitably connected to the steam supply thereof, as shown. This very hot flux oil is thus combined with the somewhat cooler (e. g. 600° F.) unvaporized liquid residue resulting from the flash vaporization occurring in tower 11. The volume of the material pumped through pipe still 14 by pump 53, and discharged at 84 into tower 12, is thus augmented materially and its total available heat content much increased without the necessity of increasing the predetermined desirable pipe still discharge temperature into tower 12. This re-circulation of flux oil from tower 12 therefore accomplishes the desired purpose of effecting the maximum vaporization of heavy lubes in tower 12 at a lower pipe still discharge temperature than would otherwise be feasible. An additional advantage gained by re-circulating the residual unvaporized material from the base of tower 12 is that it permits maintenance of a constant thruput through the tubes of pipe still 14 and facilitates the operation at a constant discharge temperature into tower 12, irrespective of possible variations in operating conditions to a greater or less extent in the preceding parts of the distillation system.

What is claimed is:

1. In a plant for the manufacture of lubricating oil distillates, apparatus comprising a flash and fractionating tower, means for delivering heated charging stock to the vaporizing zone of said tower, means for withdrawing fractionated products from said tower in side stream, a second flash and fractionating tower, a pipe still heater, means for continuously withdrawing liquid oil residue from said first tower, passing it through said heater and delivering it to the vaporizing zone of said second tower, means for withdrawing fractionated products from said second tower in side stream, means for withdrawing liquid oil residue from said second tower and delivering it to the vaporizing zone of said first tower, means for controlling the rate at which liquid oil residue is delivered to said first tower to maintain therein a body of liquid oil residue of substantially constant volume, and means for maintaining low absolute pressure in said towers.

2. A high vacuum distillation system for the manufacture of mineral lubricating oils as overhead distillates which comprises, in combination, a flash and fractionating tower provided with a vaporizing section, an entrainment-separating section, a fractionating section and an accumulator for receiving unvaporized liquid oil residue, means for delivering heated charging stock to said vaporizing section, means for withdrawing fractionated products from said tower in side stream, a second flash and fractionating tower provided with a vaporizing section, an entrainment-separating section and a fractionating section, a pipe still heater, means for continuously withdrawing liquid oil residue from said accumulator, passing it through said heater and delivering it to the vaporizing section of said second tower, means for withdrawing fractionated products from said second tower in side stream, means for conducting unvaporized liquid oil residue from said second tower to said accumulator, means for varying the rate at which liquid oil residue from said second tower is conducted to said accumulator to maintain therein a body of liquid oil residue of substantially constant volume, and vacuum-producing means connected to the vapor outlet of each tower for withdrawing vapors therefrom and maintaining low absolute pressure therein.

3. A high vacuum distillation system for the manufacture of mineral lubricating oils as overhead distillates which comprises, in combination, an initial flash and fractionating tower provided with a vaporizing section, an entrainment-separating section and a fractionating section; means for delivering heated charging stock to said vaporizing section; means for withdrawing fractionated products from said tower in side stream; a second flash and fractionating tower provided with a vaporizing section, an entrainment-separating section, a fractionating section, a condensing means, and an accumulator for receiving unvaporized liquid oil residue; means for withdrawing fractionated products from said second tower in side stream; conduit means whereby charging stock may be passed through said condensing means to serve as cooling medium therein and to be preheated prior to delivery to said vaporizing section of said initial tower; a pipe still heater; conduit means whereby unvaporized liquid oil residue may be led from said initial tower, passed through said heater, and delivered to the vaporizing section of said second tower; a third flash and fractionating tower provided with a vaporizing section, an entrainment-separating section and a fractionating section; a second pipe still heater; means for continuously withdrawing liquid oil residue from said accumulator, passing it through said second heater and delivering it to the vaporizing section of said third tower; means for withdrawing fractionated products from said third tower in side stream; means for conducting unvaporized liquid oil residue from said third tower to said accumulator; means for varying the rate at which liquid oil residue from said third tower is conducted to said accumulator to maintain therein a body of liquid oil residue of substantially constant volume; and vacuum-producing means connected to the vapor outlet of each tower for withdrawing vapors therefrom and maintaining low absolute pressure therein.

4. In a high-vacuum distillation system for the manufacture of mineral lubricating oils as overhead distillates, the combination, with means for heating lubricating oil charging stock to flashing temperature, of a tower having a vaporizing section into which the heating means is arranged to discharge heated charging stock; an entrainment-separating section above said vaporizing section, comprising means for laterally deflecting and imparting considerable velocity and centrifugal action to the ascending vapors to throw out entrained liquid, and means for collecting resultant separated liquid; a fractionating

section above said entrainment-separating section comprising a series of alternating ring plates and deflector plates and curved guide vanes associated with said plates to impart whirling movement to the ascending vapors; means disposed above said fractionating section for condensing vapors therefrom and for delivering liquid reflux condensate thereto; a second fractionating section disposed above said condensing means and comprising a series of alternating ring plates and deflector plates and curved guide vanes associated with said plates to impart whirling movement to the ascending vapors; means disposed above said second fractionating section for condensing vapors therefrom and for delivering liquid reflux condensate thereto; means for withdrawing fractionated products from said tower in side stream; and vacuum-producing means connected to the vapor outlet of said second fractionating section and capable of maintaining a low absolute pressure at such outlet.

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