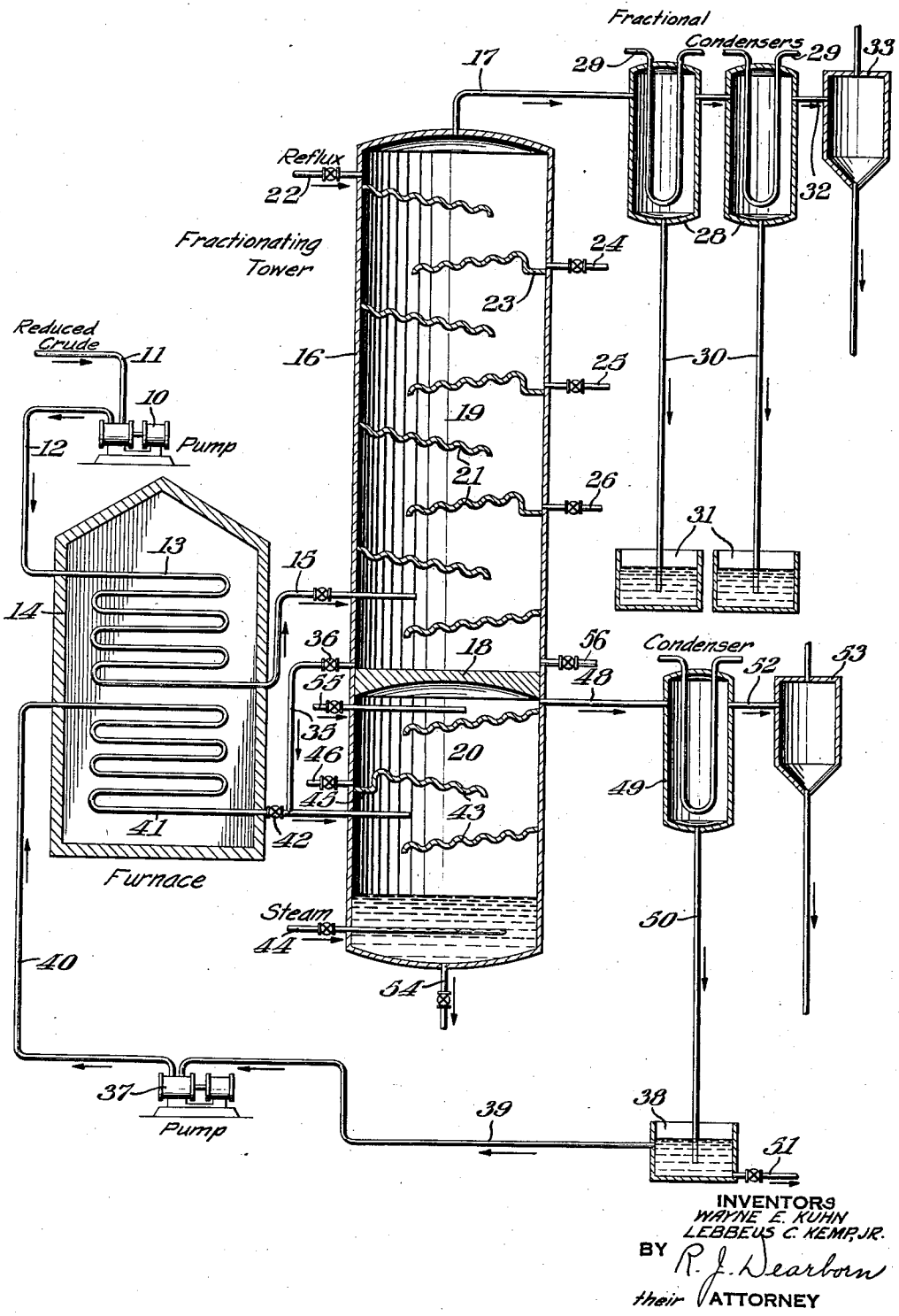
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MINERAL OIL DISTILLATION

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MINERAL OIL DISTILLATION

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This invention relates to the distillation of hydrocarbon oils, and more particularly to the vacuum distillation of a topped crude oil to produce lubricating oil distillates and asphalt in a continuous process.

In co-pending application Serial No. 622,042, filed July 12, 1932, there is described the distillation of a topped crude oil by heating to a temperature below a normal cracking temperature, separately heating a lighter more refractory oil, such as a gas oil or kerosene, to a materially higher temperature in excess of a normal cracking temperature, mixing the oils and simultaneously flashing into a fractionating tower, from which various lubricant distillate fractions are withdrawn together with an asphaltic residuum. In co-pending application Serial No. 623,921, filed July 22, 1932, there is described the distillation of a lubricant containing mineral oil by heating to a high temperature without cracking, flashing into a dry vacuum zone and fractionating therein to separate lighter and intermediate lubricating oils as side streams, and then passing the residuum without further heating into a wet vacuum zone where it is subjected to further distillation with the aid of steam, whereby heavier lubricating distillates are obtained. The present invention relates to improvements in the above described methods, and in apparatus for carrying out the improvements, whereby improved results and substantial economy in operation are effected.

In the U. S. patent to Coubrough No. 1,905,156, it has been suggested to separate lighter and intermediate lubricant fractions from a reduced crude oil, then mix a lighter oil such as a gas oil with the unvaporized residue, heat the mixture in a tube still to a temperature below cracking, followed by flashing into a fractionating tower into which steam is introduced for stripping the residuum, to obtain heavy lubricant fractions and asphalt as a residuum. In practice, it is found that substantial quantities of steam are required in order to reduce the residuum to an asphalt of the proper penetration.

It is an object of the present invention to provide a method of distillation of this character, whereby lubricant fractions may be substantially completely separated and asphalt of proper penetration obtained as a residuum, while effecting material economy in the consumption of steam, and to provide simplified and economical apparatus for this purpose.

The invention contemplates a method of distilling a hydrocarbon oil, such as a topped crude oil, by heating the oil to an elevated temperature without cracking, flashing into a dry vacuum fractionating zone where lighter and intermediate lubricant fractions are obtained together with a heavy unvaporized residue, separately heating a lighter more refractory oil, such as a gas oil or kerosene, to a high temperature at which it will flash into vapor when introduced into a vacuum chamber, and flashing the unvaporized residue together with the heated lighter oil into a separate vacuum fractionating zone, to which steam may be supplied to assist the distillation, and from which a heavy lubricant distillate fraction is separately obtained from the light oil distillate, and an asphaltic or tarry residue is removed as residuum.

The invention will be better understood in connection with the accompanying drawing which is a diagrammatic view of a preferred embodiment of apparatus suitable for carrying out the process of the invention.

Referring to the drawing, a pump 10 having a suction line 11 and a discharge line 12 is arranged to deliver oil from a source (not shown) to a heating coil 13 situated in the upper portion of a tube still furnace 14. The oil is preferably a reduced asphalt bearing crude, from which lighter constituents, including gasoline, kerosene and gas oil, may have been substantially removed in an atmospheric tube still distillation unit of conventional character. The oil is rapidly heated without any substantial cracking to a high temperature, for example about 750° to 800° F. or above, and then flashed by transfer line 15 into fractionating tower 16.

The fractionating tower 16 is divided by an impervious partition 18 into an upper dry vacuum section 19 and a lower wet vacuum section 20. While any suitable construction of fractionating devices may be employed, that shown, consisting of a plurality of staggered downwardly inclined corrugated baffles 21, is found to function very satisfactorily, enabling a high vacuum to be maintained throughout the tower while still obtaining adequate fractionation and refluxing. Reflux liquid is introduced by line 22. Certain of the baffles 21 are provided with liquid collecting sumps 23, from which lubricant side streams may be withdrawn through the valve controlled lines 24, 25 and 26. Uncondensed vapors pass overhead by line 17 to one or more coil condensers 28, to which cooling medium is introduced by lines 29. Condensate is removed from the condensers by gravity legs 30 to storage tanks 31. Any lighter vapors and incondensable gases pass

from the condensers through line 32 to a suitable jet or barometric condenser 33, or to a series of such jet condensers whereby a high vacuum equivalent to an absolute pressure of 25 to 50 mm. Hg. or less may be produced.

Unvaporized residuum, collecting in the bottom of the dry vacuum section 19 is passed through back-trapping line 35 controlled by valve 36, which serves to introduce the residuum into the lower wet vacuum section 20 of the tower. A pump 37 withdraws a lighter more refractory oil, such as a gas oil or kerosene distillate, from tank 38 through suction line 39 and forces the oil through pressure line 40 to a heating coil 41 arranged in the lower hotter portion of furnace 14. The oil is here heated to a high temperature which is sufficient to reheat the residuum to about the temperature at which it was introduced into the dry vacuum section, and which causes the lighter oil to flash into vapor in the wet vacuum section to serve as a distilling medium. The highly heated lighter oil at a temperature of around 800° to 950° F. then passes by transfer line 42 into the back-trapping connection 35, where it is mixed with the unvaporized residue from the dry vacuum section of the tower, and the mixture having a temperature of the order of 750° to 810° F. or somewhat higher is flashed at an intermediate point in the wet vacuum section 20. Any suitable fractionating equipment may be provided for this section of the tower, such as the inclined corrugated baffles 43 shown. A pipe connection 55 is provided leading into the upper portion of the chamber 20 for supplying a reflux or cooling medium thereto. Steam or an inert gas stripping medium may be introduced into the base of section 20 by line 44. One or more of the baffles 43 may be provided with a sump 45, from which a side stream of heavy lubricant distillate may be withdrawn by the valve controlled line 46. The arrangement is such that heavy viscous oil vaporized in the wet vacuum section 20 is substantially condensed therein and withdrawn as a side stream, while the light distillate oil passes overhead by line 48 to coil condenser 49, where it is condensed and returned by gravity leg 50 to tank 38. Any water, which may be condensed and accumulated in tank 38, is allowed to separate, and may be withdrawn through valve controlled discharge 51. Uncondensed vapors and gases pass overhead from condenser 49 by line 52 to a suitable jet or barometric condenser 53, which serves to maintain a high vacuum equivalent to an absolue pressure of 25 to 50 mm. Hg. or less on the section 20. With the arrangement shown, the absolute pressure may be readily carried and maintained as low as 4 to 6 mm. Hg. Asphaltic residuum is withdrawn from the base of section 20 by valve controlled discharge 54.

By means of the present invention, the lighter and intermediate lubricant fractions are readily distilled and fractionally condensed under high vacuum, which can be more effectively maintained due to the absence of steam. The heavy unvaporized residue, containing the heavy viscous lubricating oil fractions, which normally cannot be distilled without appreciable cracking, is then directly mixed with the highly heated more refractory lighter oil, which imparts additional heat to the residue and raises it to a high temperature. Due to the extremely short interval of time in which the oil is maintained at this high temperature, decomposition thereof is substantially prevented. The high vacuum, coupled with the vapor pressure effect of the lighter oil, as well as the vapor pressure effect of the stripping steam, enables a substantially complete separation of the viscous lubricating oils from the residue, with the result that a hard asphalt may be directly obtained as residuum. Due to the fact that the gas oil or kerosene is not mixed with the bulk of the reduced crude, but only with the unvaporized residue from the dry vacuum section after the lighter and intermediate lubricating oils have been distilled off, a smaller proportion of the lighter oil may be employed. Consequently, the quantity of recirculating light oil is reduced, placing a decreased load on the heater and condensing equipment. As the unvaporized residue from the dry vacuum section represents only a fraction of the volume of the original reduced crude, the reduction in volume of lighter oil is therefore considerable. By separating the distillation of the lighter and intermediate lubricant fractions from the heavier lubricant fractions, and by carrying out the former in a dry vacuum, a smaller diameter tower may be employed, and less difficulty is experienced in maintaining a suitably high vacuum.

In certain cases, it may be feasible to dispense entirely with the use of steam in the lower section 20 of the tower. This may be accomplished by increasing the heat input by raising the temperature of the lighter oil, or by increasing the proportion of the lighter oil for a given temperature. Or, an inert stripping medium, such as a fixed hydrocarbon gas, may be substituted for the steam. Avoidance of the use of steam possesses the advantage that the condensing and vacuum producing equipment is simpler and operates more efficiently. In any event, only relatively small quantities of steam are required to reduce the residuum to an asphalt of suitable penetration, such for example as an A. S. T. M. penetration of from 1 to 4. For example, it has been found that, with the proportions and temperatures of the oils as set forth above, a quantity of steam varying from about 20 to 5 pounds or less per barrel of reduced crude resulted in a reduction to an asphaltic bottoms representing about 4 to 6% weight on the weight of the reduced crude.

While the invention is particularly suitable for the simultaneous production of distillate lubricating oils and asphalt in a continuous process, it may be used to advantage to distill residual or distillate oils to obtain lubricant distillate fractions and a heavy residuum or cylinder stock. For example, a heavy distillate oil or a reduced crude may be treated as above; or the oil may be heated to a temperature below a normal cracking temperature, such as below aboout 700° F., then flashed into the dry vacuum section where lighter lubricant distillate fractions are obtained, the residue is then flashed together with a lighter oil, which has been separately heated to a temperature materially above a normal cracking temperature for the heavy oil, such as around 800° to 950° F., into the wet or second vacuum zone where distillation may or may not be aided with steam, and where heavier lubricant distillate fractions are obtained together with an asphaltic residuum or heavy cylinder stock. In this manner, advantage is taken of high flashing temperatures, high vacuum, vapor pressure effect of the lighter oil, and short time of treatment at the high temperatures to secure viscous lubricant distillate oils while effectively avoiding any substantial cracking.

While the invention has been particularly de-

scribed in connection with the employment of a dry vacuum in the upper fractionating section of the tower, it may be desirable in certain instances to operate with the introduction of steam or an inert stripping medium in this section, and a line 56 is shown for the purpose of introducing such a medium. This may be employed with a somewhat lower vacuum in the tower, and any cooling effect of the stripping steam or other medium may be compensated by the temperature and/or proportion of the lighter oil flashed with the residuum from the upper section into the lower section of the tower.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. The method of separating lubricating oils and asphalt from a topped crude oil in a continuous process, which comprises heating the topped crude oil to a distillation temperature while avoiding any substantial decomposition thereof and passing the oil into a fractionating zone, fractionating the oil therein while maintaining a substantial dry vacuum to produce distillate lubricating oil fractions and a heavy unvaporized fraction, withdrawing the latter, separately heating a lighter more refractory oil to a temperature materially above the temperature of the withdrawn unvaporized fraction, simultaneously flashing the withdrawn unvaporized fraction and the lighter more refractory oil into a separate vacuum fractionating zone in such manner that additional heat is imparted from the lighter more refractory oil to the heavy fraction to thereby raise the temperature of the heavy fraction to a distillation temperature, but for such a relatively short period of time that any substantial decomposition thereof is prevented, fractionating the mixture therein, while introducing steam into the separate fractionating zone to assist in the distillation therein to obtain a heavy distillate lubricating fraction, and removing an asphalt as residuum from the separate fractionating zone.

2. The method of separating lubricating oils and asphalt from a topped crude oil in a continuous process, which comprises heating the topped crude oil to a temperature of around 750° to 800° F. while avoiding any substantial cracking thereof, passing the heated oil into a fractionating zone and fractionating therein while maintaining a substantial dry vacuum to produce distillate lubricating oil fractions and a heavy unvaporized fraction, withdrawing the latter, separately heating a lighter more refractory oil to a temperature materially above the temperature of the withdrawn unvaporized fraction, mixing the heavy unvaporized fraction and the lighter more refractory oil and flashing the mixture into a separate vacuum fractionating zone and fractionating therein while introducing steam into the separate fractionating zone to assist in the distillation and to obtain a heavy distillate lubricating fraction, and removing an asphalt as residuum from the separate fractionating zone.

3. The method of distilling a heavy hydrocarbon oil containing lubricant fractions, which comprises heating the heavy oil in a confined stream to a distillation temperature while avoiding any substantial cracking thereof and flashing into a fractionating zone, fractionating the oil therein while maintaining a substantial dry vacuum to produce distillate lubricating oil fractions and a heavy unvaporized fraction, withdrawing the latter, separately heating a lighter more refractory oil to a temperature materially above the temperature of the withdrawn heavy unvaporized fraction, mixing the withdrawn heavy fraction with the highly heated lighter oil, flashing the mixture into a separate vacuum fractionating zone and fractionating therein to separate a heavy lubricant distillate fraction from the lighter oil, stripping the residuum in the separate fractionating zone with steam, and withdrawing the stripped residuum therefrom.

4. Vacuum distillation apparatus of the character described, comprising in combination, a fractionating tower having separate dry vacuum and wet vacuum fractionating sections, a tube still flashing into the dry vacuum section, a connection for back-trapping residuum from the dry vacuum section directly into the wet vacuum section, a separate heating coil discharging into the back-trapping connection, and means for passing an oil through the separate heating coil and thence into the back-trapping connection, from where the mixture is flashed into the wet vacuum section of the tower.

5. Vacuum distillation apparatus of the character described, comprising in combination, a fractionating tower having an upper vacuum fractionating section and a lower vacuum fractionating section, the upper and lower sections being closed from each other and having separate vapor withdrawals, a tube still flashing into the upper vacuum section, a connection for back-trapping residuum from the upper vacuum section directly into the lower vacuum section, and a separate heating coil discharging into the back-trapping connection, whereby a heated oil is mixed with the residuum and the mixture flashed into the lower vacuum section of the tower.

6. The method of separating lubricating oils and asphalt from a topped crude oil in a continuous process, which comprises heating the topped crude oil to a temperature at which cracking would take place if the oil were maintained at such temperature for any appreciable length of time, flashing the heated oil before any substantial cracking thereof occurs into a fractionating zone, fractionating the oil therein while maintaining a substantial dry vacuum to produce distillate lubricating oil fractions and a heavy unvaporized fraction, withdrawing the latter, separately heating a lighter more refractory oil to a temperature materially above the temperature of the withdrawn unvaporized fraction, mixing the highly heated refractory oil with the withdrawn unvaporized fraction and flashing the mixture into a separate vacuum fractionating zone closed from vapor communication with the first mentioned fractionating zone, additional heat being imparted from the lighter more refractory oil to the heavy fraction to raise the latter to a distillation temperature, but for such a relatively short period of time that any substantial cracking thereof is prevented, fractionating the mixture therein while introducing steam into the separate fractionating zone to assist in the distillation and to obtain a heavy distillate lubricating fraction, and removing an asphalt as residuum from the separate fractionating zone.

7. Vacuum distillation apparatus of the char-

acter described, comprising in combination, a fractionating tower having an upper dry vacuum section and a lower wet vacuum section closed from vapor communication with each other, separate vapor withdrawals from the said upper dry vacuum section and the said lower wet vacuum section, separate vacuum producing means connected to the said vapor withdrawals, a tube still flashing into the upper dry vacuum section, a connection for back-trapping residuum from the upper dry vacuum section directly into the lower wet vacuum section, a separate heating coil discharging into the back-trapping connection, whereby a heated oil is mixed with the residuum and the mixture flashed into the lower wet vacuum section of the tower, and means for introducing steam into the lower wet vacuum section of the tower.

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