

April 16, 1935.

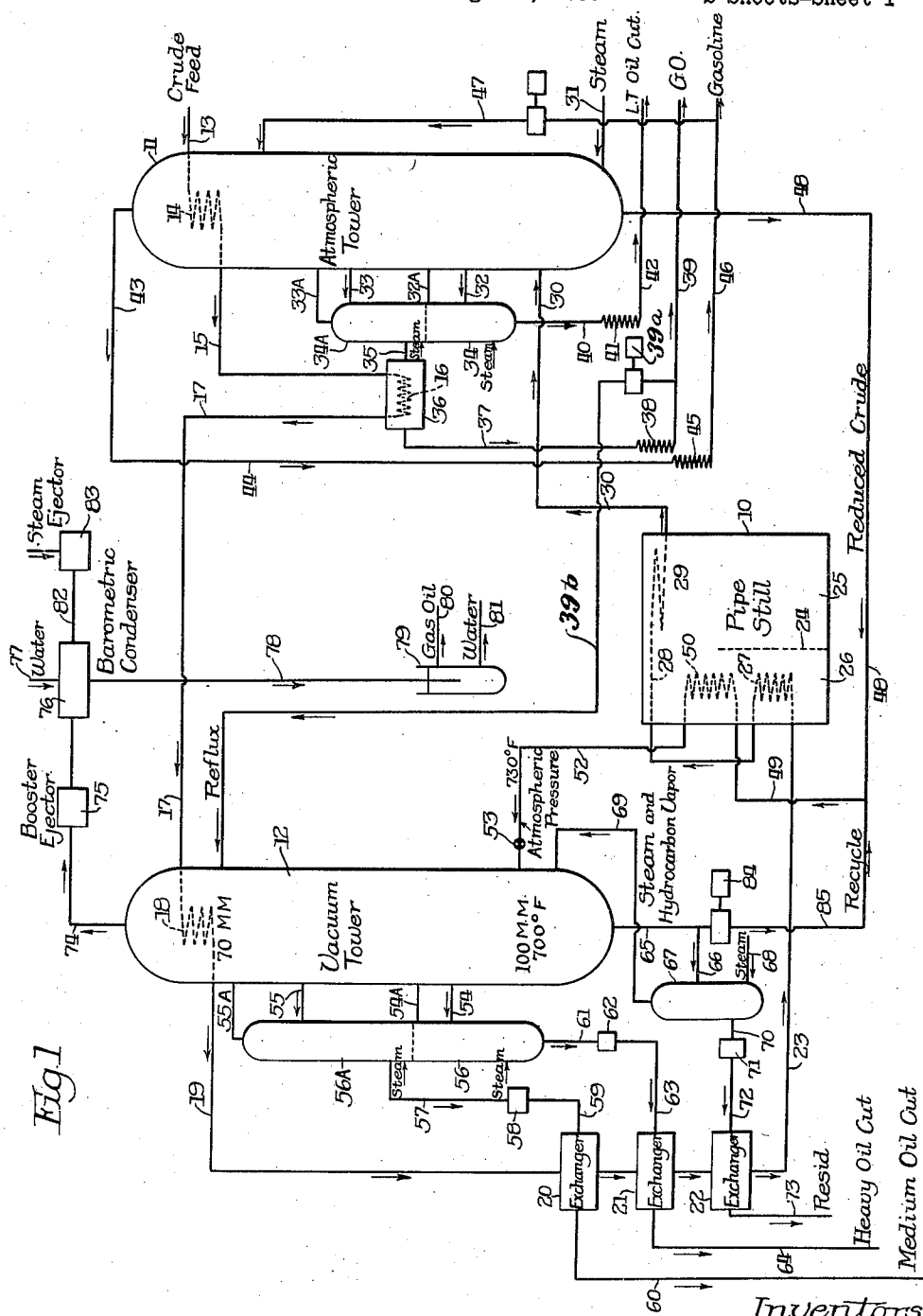
W. H. BAHLKE ET AL

1,997,675

DISTILLATION

Filed Aug. 28, 1930

2 Sheets-Sheet 1



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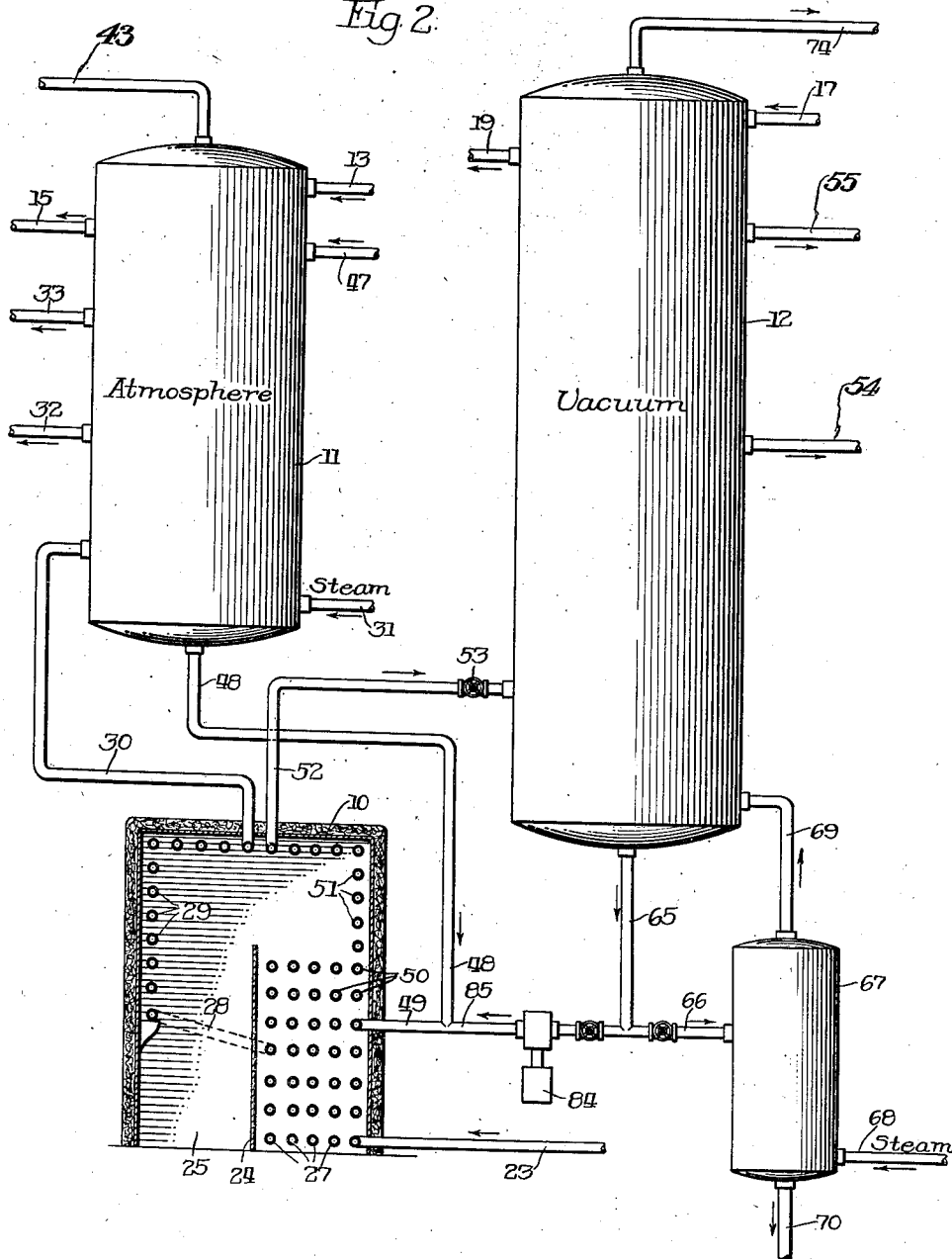
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Fig. 2.



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UNITED STATES PATENT OFFICE

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DISTILLATION

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Application August 28, 1930, Serial No. 478,340

14 Claims. (Cl. 196—77)

This invention relates to a distillation system wherein the liquid is heated in a closed conduit and then flashed in a separator, the heat stored in the liquid being sufficient to vaporize a prede-
5 terminated fraction thereof.

The object of this invention is to reduce the pipe still temperature to which a liquid must be heated in order to vaporize a given fraction there-
10 of. A further object is to provide an improved system for refining petroleum hydrocarbons, and particularly for producing overhead lubricating fractions at a pipe still temperature low enough to prevent substantial cracking. Other objects will be apparent as the detailed description of our
15 invention proceeds.

The invention contemplates the mixing of a non-volatile liquid with a charging stock and heating the mixture in a pipe still whereby the liquid stores enough sensible heat to effect com-
20 plete vaporization of a given fraction of the charging stock when it is introduced into a flash drum or separator chamber. The invention is particularly useful in the distillation of lubricating oils because it affords a means of keeping the
25 temperature of the oil in the pipe still low enough to prevent substantial cracking. The liquid which is mixed with the charging stock is preferably a portion of the hot residue from the flash chamber.

In the accompanying drawings wherein similar parts are designated by like reference characters
30 in the several views,

Figure 1 is a flow sheet or diagrammatic plan of a distillation system for petroleum hydrocarbons, and

35 Figure 2 is a detail of said system, showing the relative positions of the bubble towers to the pipe still.

The invention will be described as applied to the distillation of petroleum, but it is understood
40 that the principles of the invention are applicable to the distillation of other liquids. In the system diagrammatically illustrated in Figure 1, crude oil is heated in pipe still 10, gasoline and light ends are flashed and removed in tower 11 at at-
45 mospheric pressure, and the bottoms from this tower are mixed with a non-volatile liquid, passed through other coils in pipe still 10, and finally introduced into vacuum tower 12, wherein the sen-
50 sible heat of the liquid causes the complete vaporization and separation of the lubricating fraction of the oil.

The crude oil is introduced through pipe 13 to reflux coil 14 in atmospheric tower 11. The pre-
55 heated crude is then conducted through pipe 15, coil 16, pipe 17, coil 18, pipe 19, heat exchangers

20, 21 and 22 and pipe 23 to the lower bank of convection coils 27 in pipe still 10. The oil is con-
ducted from these convection coils by pipe 28 to the roof tubes 29 in the still and thence by pipe
30 to the base of the atmospheric tower 11.

Tower 11 may be at atmospheric pressure and may be provided with suitable baffles and/or bub-
ble plates in accordance with conventional prac-
tice. The particular structure of the fractionat-
ing tower forms no part of this invention and will
10 not be described in detail. The hot oil is stripped in the base of the tower by steam introduced through pipe 31. A light oil cut is removed from an intermediate point by pipe 32 and a gas oil
15 cut is removed at a higher intermediate point 33. These cuts are stripped in superimposed strippers 34 and 34—A by means of steam or hydrocarbon
gases. The stripped vapors and gases are re-
turned to the tower through pipes 32—A and
33—A respectively.

Gas oil is withdrawn through pipe 35, crude
preheater 36, pipe 37, cooler 38 and pipe 39 to a suitable storage tank. A part of the gas oil
20 from pipe 39 or from the storage tank is returned by pump 39a through pipe 39b to the top of vac-
uum tower 12 wherein it serves as reflux. The light oil cut is withdrawn from the base of tower
34 and is conducted through pipe 40, cooler 41, and pipe 42 to a suitable storage tank. Gasoline
vapors are removed from the top of tower 11 and
30 are conducted through pipe 43, pipe 44, cooler 45 and pipe 46 to a suitable storage tank. A por-
tion of the gasoline is passed through pipe 47 to the upper part of tower 11 and is introduced as
a reflux over the top bubble plates.

The residue, "bottoms", or reduced crude is
35 withdrawn from the base of tower 11 through pipes 48 and 49 to the upper bank of convection coils 50 of pipe still 10. The hot reduced crude is then passed through suitable radiant or wall
40 tubes 51, thence pipe 52 and valve 53 into the flash chamber in the base of vacuum tower 12, which is likewise provided with suitable bubble plates, baffles, etc. A heavy oil cut may be taken from an intermediate point of tower 12 through
45 pipe 54 and a medium oil cut may be withdrawn through a higher intermediate point of pipe 55, both of these cuts being stripped in superimposed
strippers 56 and 56—A, the vapors and gases be-
ing returned to the tower through pipes 54—A
50 and 55—A respectively.

The medium oil cut from stripper 56—A goes
through pipe 57, pump 58, pipe 59, exchanger 20
and pipe 60 to a suitable storage tank. The
55 heavy cut is passed through pipe 61, pump 62,

pipe 63, exchanger 21 and pipe 64 to a storage tank.

The non-volatile residue is withdrawn from the base of the tower through pipe 65. A portion of this residue is conducted by pipe 66 to a stripping tower 67 and is therein stripped by steam introduced through pipe 68. The steam and vaporized hydrocarbons are conducted by a pipe 69 from the stripper to the base of tower 12, where they are used to strip the hot reduced crude. The final residue is withdrawn through pipe 70, pump 71, pipe 72 and exchanger 22, and pipe 73 to a suitable storage tank.

A conduit 74 connects the top of vacuum tower 12 with a booster ejector 75, and barometric condenser 76. Water is introduced into the barometric condenser through pipe 77, and a mixture of water and gas oil is withdrawn through pipe 78 to a barometric seal 79 from which gas oil is withdrawn by pipe 80 and water is withdrawn by pipe 81. A pipe 82 connects barometric condenser 76 with steam ejector 83.

A portion of the residue from pipe 65 is forced by pump 84 through pipes 85 and 49 to the upper bank of convection tubes 50. This portion of the residue is called recycle stock and it is heated with the reduced crude in a pipe still for a purpose which will be hereinafter explained.

The operation of our invention may be briefly described as follows: The crude oil is passed through the preheaters and exchangers, and thence through the pipe still, where it is heated to about 600° F. It is then flashed in atmospheric tower 11 and the reduced crude is returned to the pipe still, heated to a temperature of about 730° F. and introduced into the base of vacuum tower 12. The absolute pressure at the base of the tower is preferably about 100 mm. and at the top of the tower it is about 70 mm. The temperatures of the various strippers, coolers, preheaters, etc. form no part of the present invention and will not be described in detail.

When two cuts of lubricating oil are taken from the vacuum tower 12, the temperature at the base of the tower is preferably about 700° F. If a straight reduced crude is heated in the pipe still and charged into the vacuum tower, the oil must be heated in the pipe still to a temperature of 760° in order to vaporize the desired fractions at a temperature of 700° at the base of the tower. If, on the other hand, an equal volume of recycle stock is mixed with the reduced crude, the final temperature in the pipe still need only be 730° F. to completely vaporize the same fractions in the vacuum tower at a temperature of 700° F. If one part of the reduced crude is mixed with two parts of recycle stock, the final temperature in the pipe still can be lowered to 720° F., and if the ratio of reduced crude to recycle stock is 1 to 4, the temperature may be reduced to nearly 710° F.

When separating light and heavy fractions (instead of medium and heavy fractions), recycling is still more effective in lowering the required temperatures in the pipe still. Mixing two parts of reduced crude with three parts of recycle lowers the temperature 30°; using equal parts lowers the temperature 40°, and using three parts of reduced crude to five of recycle lowers the temperature 50°.

These results may be explained as follows, (although we do not limit ourselves to any theory of action): Since the pipe still is operating at a higher pressure than the vacuum tower, a portion at least of the oil which it is desired to vaporize remains in liquid form in the pipe still. When it

is discharged into the lower part of the vacuum tower, the sensible heat of the oil must be sufficient to supply the latent heat required for vaporizing the fraction to be distilled. The reduced crude must be heated to a relatively high temperature in order to supply this sensible heat. By increasing the volume of non-volatile liquid, we make it possible to supply this sensible heat at lower pipe still temperatures.

While we have described a preferred embodiment of our invention it is understood that the invention is not limited to the distillation of petroleum oils or to any of the temperatures, pressures or other conditions hereinabove set forth.

The term "non-volatile" is used herein to define all liquids which are substantially non-volatile at distillation temperatures and pressures. The recycle stock is non-volatile according to this definition, and it is particularly suitable in our invention, because it already possesses a considerable amount of heat and because it cannot deleteriously affect the oil.

When distillation must be carried out at or near the range of cracking temperatures in the usual type of apparatus, the required temperature can be considerably lowered by employing the method of recirculation of non-volatile liquid as described above, with consequent reduction in amount of cracking and improvement in yield and quality of distillate obtained.

We claim:

1. In a system for refining petroleum hydrocarbons, an atmospheric tower, means for heating crude petroleum and for introducing the hot petroleum into said tower, means for fractionating it into gasoline, gas oil, light oil and reduced crude, means for heating the reduced crude, means for introducing the hot reduced crude into a vacuum tower, means for fractionating said reduced crude into lubricating oil and residue, means for mixing a part of said residue with said reduced crude before said reduced crude is passed through said second heating means, and means for returning gas oil from the atmospheric system to serve as a reflux near the top of the vacuum tower.

2. The method of continuously distilling lubricating oils without substantial cracking, which comprises heating a confined stream of reduced crude in a heating zone, introducing the hot mixture into a vacuum zone, and mixing part of the residue from said vacuum zone with the stream of reduced crude entering said heating zone whereby the sensible heat of liquids introduced into the vacuum zone is sufficient to supply the latent heat of evaporation of the lubricating fraction of the oil thereby separating said lubricating fraction from the non-volatile residue in said vacuum zone.

3. The method of distilling lubricating oils from reduced crudes without cracking which comprises admixing about one to four parts of non-volatile hydrocarbons with each part of reduced crude, continuously heating the mixture in a stream to a temperature of about 30° to 50° lower than the temperature which would be required in the absence of added non-volatile hydrocarbons; flashing the mixture whereby the sensible heat of the added liquids supplies a portion of the latent heat of vaporization of the oils and separately removing vaporized lubricating oils from the residual liquids.

4. A process of continuously refining petroleum hydrocarbons without substantial cracking there-

of, which comprises withdrawing from a fractionating zone a residue which is substantially non-volatile under the conditions of pressure and temperature prevailing in said zone, mixing said residue with oil to be refined, passing said mixture through a heating zone under a pressure greater than that existing in the fractionating zone and heating said mixture under temperature conditions at which no substantial cracking takes place, introducing said heated mixture under vacuum into said fractionating zone, whereby the heat required to volatilize the desired parts of the oil being refined is supplied in part at least by the non-volatile residue mixed therewith.

5. A process of continuously refining petroleum hydrocarbons without substantial cracking thereof, which comprises withdrawing from a fractionating zone a residue which is substantially non-volatile under the conditions of pressure and temperature prevailing in said zone, mixing said residue with reduced crude containing a vaporizable lubricating oil fraction, passing said mixture in a confined stream through a heating zone under a pressure greater than that in the fractionating zone and heating said mixture to a temperature at which no substantial cracking takes place and which is below that temperature at which vaporization would take place in the absence of added residue, introducing said heated mixture under vacuum into the fractionating zone whereby the heat required to volatilize a lubricating fraction from the reduced crude is supplied in a large part at least by the non-volatile residue mixed therewith.

6. A continuous process of refining a reduced crude oil which comprises withdrawing from a vacuum zone a residue which is substantially non-volatile under the conditions of pressure and temperature prevailing in said zone, mixing from one to four parts of said residue with each part of reduced crude to be refined, passing said mixture in a confined stream through a heating zone and heating said mixture to a temperature which is below that temperature at which vaporization would take place in the absence of added residue and at which no substantial cracking takes place, introducing said heated mixture into the vacuum zone and flashing the mixture therein, whereby the heat required to volatilize the lubricating fractions of the reduced crude is supplied in a large part by the non-volatile residue mixed therewith.

7. A method of recovering oils from petroleum bottoms containing asphalt which consists in adding to the original bottoms a quantity of asphalt having high heat storage capacity, heating the mixture, continuously admitting the heated mixture into a vaporizing zone in counter-current with steam to vaporize the oils by the heat stored in the mixture, the quantity of added asphalt being sufficient to maintain the temperature against depression to a point below which vaporization cannot continue, until substantially complete vaporization of the oils has been effected.

8. A method of separating heavy oils from bottoms containing asphalt which consists in adding to the bottoms a quantity of asphalt to act as a heat storage medium, heating the mixture, and admitting the heated mixture into a vaporizing zone in counter-current with steam, the quantity of asphalt added being sufficient to supply the heat of vaporization of the oils without excessive depression of temperature.

9. A method of recovering oils from petroleum bottoms containing asphalt which consists in adding to the original bottoms a quantity of asphalt having high heat storage capacity, heating the mixture, continuously admitting the heated mixture into a vaporizing zone maintained under vacuum to vaporize the oils by the heat stored in the mixture, the quantity of added asphalt being sufficient to maintain the temperature against depression to a point below which vaporization cannot continue, until substantially complete vaporization of the oils has been effected.

10. A method of separating heavy oils from bottoms containing asphalt which consists in adding to the bottoms a quantity of asphalt to act as a heat storage medium, heating the mixture, and admitting the heated mixture into a vaporizing zone maintained under vacuum, the quantity of asphalt added being sufficient to supply the heat of vaporization of the oils without excessive depression of temperature.

11. A method of separating heavy oils from bottoms containing asphalt which consists in adding to the bottoms a quantity of asphalt to act as a heat storage medium, heating the mixture, admitting the heated mixture into a vaporizing zone maintained under vacuum, the quantity of asphalt added being sufficient to supply the heat of vaporization of the oils without excessive depression of temperature, withdrawing asphalt from the vaporizing zone, and recirculating a part of the asphalt withdrawn to serve as the heat storage medium to be mixed with the original bottoms.

12. A method of separating heavy oils from bottoms containing asphalt which consists in adding to the bottoms a quantity of asphalt to act as a heat storage medium, heating the mixture, admitting the heated mixture into a vaporizing zone in counter-current with steam, the quantity of asphalt added being sufficient to supply the heat of vaporization of the oils without excessive depression of temperature, withdrawing asphalt from the vaporizing zone, and recirculating a part of the asphalt withdrawn to serve as the heat storage medium to be mixed with the original bottoms.

13. A process of continuously refining a reduced crude oil which contains a desired vaporizable fraction, which comprises continuously mixing said reduced crude with a residue, such as asphalt, which is substantially non-volatile under the conditions of heat and pressure to which the mixture is subjected, passing said mixture in a confined stream through a heating zone, heating said mixture to a temperature which is below that at which vaporization would take place in the absence of added residue and at which no substantial cracking takes place, introducing said heated mixture into a vacuum zone and separating the desired vaporizable fraction from the non-volatile residue by flashing the mixture in said vacuum zone, the heat required to vaporize the vaporizable fraction being supplied in a large part by the non-volatile residue mixed therewith.

14. A process as defined in claim 13, in which steam is introduced into the vacuum zone to assist in separating the vaporizable fraction from the non-volatile residue.

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