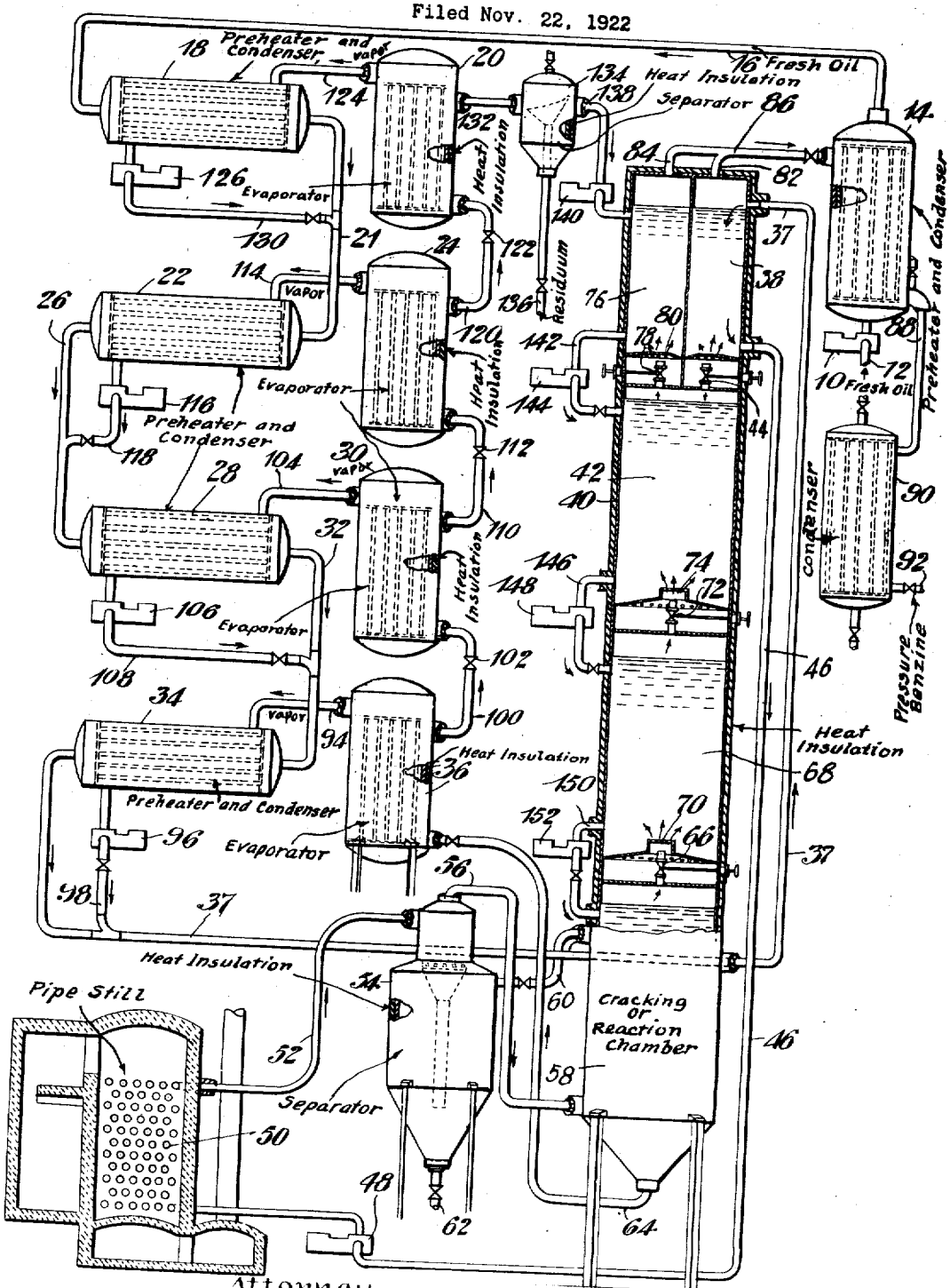
Aug. 31, 1926.

H. L. DOHERTY

1,597,674

DISTILLATION OF OIL

Filed Nov. 22, 1922



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Patented Aug. 31, 1926. 1,597,674

UNITED STATES PATENT OFFICE.

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DISTILLATION OF OIL.

Application filed November 22, 1922. Serial No. 602,508.

This invention relates to the distillation of oil and more particularly to a pressure distillation or cracking of higher boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom.

One of the main difficulties encountered in the cracking of oil is the formation of carbon. This carbon forms hard deposits on the surfaces of the apparatus in which the oil is being treated and the carbon deposits on the pipe stills and on the bottom of the shell stills are very likely to cause the stills to be burned or blistered. The formation of a carbon deposit limits the length of time that a still may be operated with safety, and the volume of oil which may be treated in the still before the operation of the still must be stopped to permit the still to be cleaned.

In a continuous cracking process of the type described in my copending application, Serial No. 361,030, filed February 24, 1920, the oil is repeatedly circulated from an unheated heat insulated cracking chamber through a directly heated pipe still and back to the cracking chamber. The continued operation of this process has shown that when the oil has been heated in the pipe still several times the carbon will deposit from the oil more rapidly than carbon will deposit from oil which has not been previously treated under cracking pressures and temperatures. It is desirable therefore that the oil passing through the heated pipe still should be as free as possible of carbon.

The primary object of the present invention is to provide a process of and apparatus for cracking oil by which the formation of carbons can be so controlled that it will not interfere with the continued treatment of oil.

With this object in view one feature of the invention contemplates cracking oil by repeatedly subjecting it to cracking conditions of temperature and pressure without directly applying heat to any oil which contains free carbon.

In the preferred process of the present invention the major part of the oil cracking is carried on in compartments of a cracking chamber to which no heat is directly applied. The heat necessary for cracking the oil in the chamber is supplied by the sensible heat and the heat of evaporation of oil and vapors which are introduced into the cracking chamber. The direct application of the heat to the oil is made in a pipe still, the preheated oil passing from the still to the cracking chamber, but no oil is circulated through the pipe still which contains free carbon.

Another object of the invention is to provide a process of forming low boiling point hydrocarbons from high boiling point hydrocarbons by alternately subjecting the oil to cracking and evaporation.

With this object in view, another feature of the invention contemplates circulating oil in a closed cycle circuit, cracking the oil by distillation under pressure and temperature in one portion of the circuit, distilling the oil by evaporating it under reduced pressure in another portion of the circuit and separately collecting condensates from the distillations in the different portions of the circuit.

The various higher boiling point hydrocarbons such as kerosene, gas oil and fuel oil do not all crack with equal facility under the same conditions of pressure and temperature. Kerosene requires higher temperatures and pressures for cracking than gas oil, and a fuel oil having a lower gravity and higher boiling point than a gas oil may be advantageously cracked at lower temperatures and pressures than the gas oil. In the present invention the oil to be cracked is maintained in a series of separate bodies by which the oil is cracked in stages, each stage having a different temperature and pressure.

Accordingly, another object of the invention is to provide a process by which oil may be cracked under different conditions of temperature and pressure in order to submit the different constituents of the oil to the most favorable conditions of cracking.

In accordance with this object, another feature of the invention contemplates passing oil as a series of separate bodies through a cracking chamber, the temperatures and pressures of the bodies increasing in the direction of flow, introducing preheated oil into the highest temperature body, circulating vapors through the bodies in a path countercurrent to the path of oil flow, and removing and condensing vapors leaving the lowest temperature body.

A further object of the invention is to

provide a process for evaporating high pressure oil residues so that the desired condensates may be recovered at the maximum temperatures and used for preheating oil passing to a heater or still.

With these and other objects in view, the invention consists in the improved process of and apparatus for cracking oil hereinafter specifically described and defined in the appended claims.

The various features of the invention are illustrated in the accompanying drawing, which shows diagrammatically an apparatus in which the preferred process of the invention may be carried out.

The preferred process of the invention may be carried out with the apparatus illustrated in the drawing substantially as follows:

A high boiling point hydrocarbon oil such as crude oil, gas oil, or fuel oil is supplied to a pump 10 through a pipe 12 and forced from the pump under pressure through a condenser 14. In passing through the condenser 14 the oil is preheated by condensing vapors leaving the cracking still. From the condenser 14 the oil flows through a pipe 16 and enters a condenser 18 where it is further preheated by vapors from an evaporating still 20. The preheated oil from the condenser 18 flows through a pipe 21 to a condenser 22 where it is further heated by vapors formed in an evaporating still 24. The preheated oil leaving the condenser 22 flows through a pipe 26 into a condenser 28 where it is further heated by vapors formed in an evaporating still 30. The preheated oil leaving the condenser 28 flows through a pipe 32 to a condenser 34 where it is further heated by vapors formed in an evaporating still 36. The preheated oil leaving the condenser 34 flows through a pipe 37 to a preheating compartment 38 of a cracking chamber 40. In the compartment 38 the oil is used to scrub cracked vapors which are formed in a cracking compartment 42 and which pass from the compartment 42 through a valved inlet 44 to the compartment 38. By scrubbing the vapors the oil is preheated and this preheated oil leaves the bottom of the compartment 38 and passes through a pipe 46 to a pump 48. The pump 48 maintains the oil under a comparatively high pressure of from 80 to 150 pounds per square inch and the size and arrangement of the tubes of a pipe still 50 are so designed that the pump circulates the oil through the tubes at comparatively high velocity. After the oil has been preheated and partially evaporated by circulation through the pipe still it flows through a pipe 52 into a separator 54. In the separator 54 the vapors are separated from the oil and pass out of the top of the separator through a pipe 56 by which they are conducted to the lower portion of the highest temperature compartment 58 of the cracking chamber 40. The preheated oil collected in the separator 54 flows out of the separator through a pipe 60 by which it is introduced into the upper part of the cracking chamber compartment 58. The separator 54 not only acts to separate the vapors from the oil, but also serves to separate carbon and heavy tarry residues from the oil. The carbon and heavy tarry residues settle to the bottom of the separator and may be intermittently drawn off through a valved outlet 62. The countercurrent circulation of the preheated oil and preheated vapors through the compartment 58 while the oil is preheated to a high temperature and maintained under a high pressure acts to thoroughly crack higher boiling point constituents to form lower boiling point constituents such as gasoline. In the chamber 58 there is comparatively little condensation and dephlegmation but the cracking operation serves to concentrate the lower boiling point hydrocarbons such as kerosene which are not readily cracked under the temperatures and pressures existing within the chamber. There is a considerable portion of the higher boiling point hydrocarbons which is not broken down by the temperatures and pressures existing in the chambers, and this mixture of uncracked residue oils leaves the bottom of the compartment 58 through a pipe 64 and passes to the highest temperature evaporator 36. The vapors passing through the compartments 58 collect in the top of the compartment and pass through a valved outlet 66 into a cracking compartment 68. The vapors discharged from the outlet 66 pass in under a distributing head 70, the head being provided with a series of perforations to distribute the vapors throughout the body of oil in the compartment 68. The oil in compartment 68 is the oil which has been previously treated at a lower temperature in compartment 42. The temperature maintained in compartment 68 is higher than the temperature maintained in compartment 42 to provide conditions for cracking the oil which is not cracked in the lower temperature compartment. The heat for maintaining the temperature in compartment 68 is supplied by vapors which are introduced into the compartment from the higher temperature compartment 58. To this end the temperature of compartment 68 is lower than the temperature in compartment 58 to provide a definite amount of condensation of insufficiently cracked vapors in the compartment 68. The pressure in the compartment 68 is lower than the pressure in the compartment 58 to such a degree that the heat supplied by the latent heat of condensation of the insufficiently cracked vapors will crack oil in the compartment 68 or furnish the heat of formation and the latent

heat of evaporation of the gasoline or other low boiling point hydrocarbons to be formed in the compartment. The uncondensed vapors passing through the compartment 68 and the vapors formed therein collect in the upper portion of the compartment and pass through a valved outlet 72 and are distributed by a head 74 into the oil of compartment 42. The oil of compartment 68 then passes into the higher temperature compartment 58 to be subjected to higher temperature and pressure stage for further cracking. The oil in the compartment 42 is the oil which has previously been treated in a low temperature compartment 76. The temperature maintained in the compartment 42 is higher than the temperature maintained in the compartment 76 to provide conditions for cracking oil which is not cracked in the low temperature compartment. The heat for maintaining the temperature in compartment 42 is supplied by vapors introduced from the compartment 68. To accomplish this the temperature in compartment 42 is lower than the temperature in compartment 68 to permit a definite amount of condensation of the insufficiently cracked vapors. The pressure in the compartment 42 is lower than the pressure in the compartment 68 to such a degree that the heat supplied by the latent heat of condensation of the insufficiently cracked vapors will crack oil in compartment 42 or furnish the heat of formation and the latent heat of evaporation of gas or lower boiling point hydrocarbons to be formed. The uncondensed vapors passing through the compartment 42 and the vapors formed therein collect in the upper portion of the compartment and are divided, one portion passing through the valved outlet 44 into the preheating compartment 38, and the other portion of the vapors passing through a valved outlet 78 under a perforated distributing plate 80 in the lower portion of the compartment 76. The oil treated in the compartment 76 is the oil supplied from the low temperature evaporator 20. The temperature of the oil in the compartment 76 is lower than the temperature of the oil in the compartment 42, to permit condensation of insufficiently cracked vapors passing from the compartment 42 through the body of the oil. The pressure in the compartment 76 is lower than the pressure in the compartment 42 to such a degree that the heat supplied by the latent heat of condensation of the insufficiently cracked vapors will crack oil in the compartment 76 or will furnish the heat of formation and the latent heat of evaporation of the gasoline or other low boiling point hydrocarbons to be formed in the compartment. The vapors passing through the compartments 38 and 76 accumulate in the tops of the compartments and flow through outlets 82 and 84 respectively into a conduit 86 by which they are conducted into the oil cooled condenser 14. The condensate or benzine distillate condensed in the condenser 14 flows through a pipe 88 into a water cooler 90 and from the cooler 90 the cooled distillate flows through a pipe 92 to a source of storage.

The residue oil which flows out of the highest temperature cracking compartment 58 contains a large amount of hydrocarbon constituents which are capable of being further cracked to form lower boiling point hydrocarbons. This oil however has been previously subjected to high temperatures and pressures or cracking conditions and now contains carbon and tarry residues which are not well suited for circulation through a still to which the heat is directly applied because the carbon and tarry residues form a carbon scale which seriously interferences with the cracking operation. In order to recover the portions of the cracked residue which are suitable for cracking, this residue is evaporated, the condensates recovered and added to the fresh incoming oil to be again recirculated through the pipe still and the residue oil which is not evaporated is returned in a closed cycle circuit through the lower temperature portion of the cracking chamber where it can be further heated and cracked to obtain any available low boiling point hydrocarbons therein.

To accomplish this the pressure of the high temperature oil flowing through the pipe 64 into the evaporator 36 is reduced to a sufficient degree to permit evaporation of a definite portion of constituents therein. These vapors pass through a pipe 94 into the condenser 34 and are condensed under pressure. By this pressure condensation comparatively high boiling point constituents may be condensed in the condenser 34 by means of preheated oil which has a comparatively high temperature. The vapors entering the condenser 34 have a comparatively high temperature, thus acting to impart a comparatively high temperature to the cooling oil of the condenser and the pressure will serve to permit the condensation of comparatively high temperature fractions. If the pressure within the condensers 34 is not as high as the pressure of oil passing through the pipe 37, a pump 96 may be used to remove condensate from the condenser 34 and force the condensate through a pipe 98 into the oil passing through the pipe 37.

The oil which is not evaported in the still 36 flows through a pipe 100 to the evaporating still 30, the pressure of the oil being reduced by means of a valve 102. By this reduction of pressure a further evaporation of the oil will take place, these vapors passing through a pipe 104 to the condenser

28. The temperature of the vapors flowing from the still 30 will be lower than the vapors passing from the still 36, and on the other hand, the oil passing through the condenser 28 is at a lower temperature than the oil passing through condenser 34. Condensation is carried on in the condenser 28 under substantially the same pressure as that maintained in the still 30 and the condensate formed is removed from the condenser by means of a pump 106 and passes through a line 108 to be added to the oil passing through the line 32. The oil which is not vaporized in the still 30 flows through a pipe 110 to the still 24, the pressure of the oil being reduced by means of a valve 112. A further evaporation of the oil takes place in the still 24, the vapors passing through a line 114 to the condenser 22, where they are condensed under substantially the same pressure as that existing in the still 24. The condensate formed in the condenser 22 is removed by means of a pump 116 and forced through a line 118 into the oil passing through the line 26. The oil which is not vaporized in the still 24 flows through a line 120 to the still 20. The pressure of the oil passing through the line 120 is reduced to substantially atmospheric pressure by means of a valve 122. In the still 20 the final evaporation of the oil takes place, these vapors passing through a line 124 into the condenser 18 and the condensate formed in the condenser is removed by a pump 126 and forced through a line 130 into the oil passing through the line 21.

The unvaporized or residue oil passing through the lowest temperature vaporizing still 20 contains a large amount of higher boiling point hydrocarbons which are available for cracking purposes. To recover this crackable oil the residue from the still 20 passes through a line 132 to a separator 134 where carbon is removed and the oil is then circulated through the cracking chamber. The carbon and heavy residue in the oil settle to the bottom of the separator 134 and may be drawn off through a valved outlet 136. The cleaned oil leaves the upper portion of the separator through a pipe 138 and is forced under pressure into the upper portion of the cracking compartment 76 by means of a pump 140. The oil which is not cracked in the compartment 76 leaves the lower portion of the compartment through a pipe 142 and is forced into the upper portion of the compartment 42 by means of a pump 144. The pump 144 is used for controlling the pressure of the oil within the compartment 42. The oil which is not cracked in the compartment 42 leaves the bottom of the compartment through a pipe 146 and is forced into the top of the compartment 68 by means of a pump 148, the pump 148 being used for controlling the pressure within the compartment 68. The oil which is not cracked in the compartment 68 leaves the lower portion of the compartment through a pipe 150 and is forced under pressure into the upper portion of the compartment 58 by means of a pump 152. The pump 152 is used to control the pressure in the compartment 58, but the pressure in the compartment 58 depends also upon the action of the pump 48 which forces oil through the pipe still and separator into the compartment 58.

With the construction described above it will be seen that the only oil which passes through the pipe still 50 is the fresh incoming oil, and the condensates which are recovered by evaporating the cracked oil. None of this oil therefore contains free carbon. After the oil has been passed into the cracking circuit it remains in the circuit until it has been completely cracked and is only removed from the circuit in the form of cracked vapors or as carbon and tarry residues. This oil circuit consists of a continuous flow through a series of compartments of a cracking chamber and a continuous flow through a series of evaporators. The oil leaves the cracking portion of the circuit from the highest temperature cracking compartment and this high temperature oil is then evaporated in stages to recover the lower boiling point constituents therefrom. The cold residue oil from the evaporating portion of the circuit is introduced into the lowest temperature compartment of the cracking chamber and as the oil advances through the compartments of the cracking chamber its temperature and pressure are increased in steps.

By the multistage cracking process outlined above, oil may be subjected to a series of different conditions of pressures and temperatures to obtain the maximum yield of gasoline or lower boiling point hydrocarbons. The oil may be partially cracked in the lowest temperature stage and the vapors formed immediately removed from the oil body and passed to the condenser. The uncracked oil then passes to a stage having a higher temperature and a correspondingly higher pressure where another portion may be cracked. In the same way the oil progresses through the series of stages and is progressively subjected to increasing temperatures to form the lower boiling point hydrocarbons in each stage. In the stage cracking a distinct constituent or group of constituents is acted upon in accordance with the temperature and pressure existing in the stage, and the vapors formed pass out of the oil body into a preceding cooler stage. As the oil advances, therefore, distinct portions of the oil are cracked and the portions of the oil which crack at the lower temperatures and pressures are removed before the oil is treated

in stages having high temperatures and pressures. Although four stages have been shown, it is not necessary to employ four stages, but more or less may be used in accordance with the character of oil. It is comparatively easy to maintain the bodies of oil at the cracking temperatures, so long as vapors are passing through the oil and the temperature of the oil is such that a portion of the vapors will condense to supply the heat necessary for cracking the oil, i. e., to supply the heat of formation and the latent heat of evaporation of the vapors being formed. By passing the vapors through the oil bodies they not only heat the oil but they are scrubbed in each compartment to condense a definite high boiling point or insufficiently cracked vapors. These condensed vapors may then be further cracked to produce the lower boiling point hydrocarbons. The cracking compartment in which these repeated and continued cracking operations are carried on is unheated and the carbon and tarry material formed may be readily removed. Furthermore, the heat supplied to the oil in the cracking compartments is not supplied from driving the heat through the walls of a still and the free carbon does not bake to form a hard deposit. The carbon remains in such a condition that it travels with the oil toward the collecting chambers and exaporators where it may be removed from the circuit. This permits the cracking operation to be made substantially continuous and to avoid the dangerous carbon deposits or crusts.

The evaporation of the cracked oil residues in a series of stages is very advantageous in that it supplies high temperature vapors for preheating oil at the place where high temperatures are necessary in order to obtain a high temperature preheating of the oil. Furthermore, by this stage evaporation comparatively high boiling point constituents may be condensed and recovered. If the residue is evaporated in one stage only, a comparatively low temperature condenser would be necessary in order to recover the low boiling point vapors, and such a low temperature condenser is not a satisfactory means for effecting high temperature heating of the oil to be cracked. Furthermore, the stage evaporation permits the latent heat of the vapors to be recovered and the absorption of the condensates in the oil used for condensing is a means by which the sensible heat of the condensates may be recovered. The only heat removed from the process is the sensible heat in the final distillate and therefore a comparatively small pipe still may be used for supplying the heat necessary for cracking a large volume of oil. As shown in the drawings, the evaporation of the residue oil is carried on in four stages. The number of evaporating stages may be varied to obtain the most advantageous conditions, depending upon the character of the oil and the temperature of the oil which is supplied to the pipe still. The invention therefore is not limited to a four stage evaporation but any desired number of stages may be used to secure the advantage of high temperature condensation and high temperature heat transfer.

The preferred form of the invention having been thus described, what is claimed as new is:

1. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising circulating oil under pressure through a heater, separating vapors from the heated oil, passing the vapors and oil through a cracking chamber while under pressure in countercurrent paths, passing residue oil from the cracking chamber to an evaporator and distilling it therein by reducing the oil pressure, condensing the residue vapors by a heat interchange with untreated oil, returning the residue oil from the evaporator to the cracking chamber and condensing vapors leaving the cracking chamber.

2. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising circulating oil under pressure through a heater, separating vapors from the heated oil, passing the vapors and oil through a cracking chamber while under pressure in countercurrent paths, circulating oil from the cracking chamber through an evaporator and returning it to the cracking chamber in a closed cycle, reducing the pressure of the oil in the evaporator to remove vapors therefrom, and condensing the vapors leaving the cracking chamber.

3. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising circulating oil under pressure through a heater, separating vapors from the heated oil, passing the vapors and oil through a cracking chamber while under pressure in countercurrent paths, passing residue oil from the cracking chamber to an evaporator and distilling it therein by reducing the oil pressure, condensing the residue oil vapors by a heat interchange with untreated oil, adding the evaporator condensate to the untreated oil for circulation through the heater, returning the residue oil from the evaporator to the cracking chamber, and condensing the vapors leaving the cracking chamber.

4. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising circulating oil under pressure through a heater,

separating vapors from the heated oil, passing the vapors and oil through a cracking chamber while under pressure in counter-current paths, circulating oil from the cracking chamber through an evaporator and returning it to the cracking chamber in a closed cycle, reducing the pressure of the oil in the evaporator to remove vapors therefrom, condensing the vapors from the evaporator and adding them to the untreated oil passing through the heater, and condensing the vapors leaving the cracking chamber.

5. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising circulating oil under pressure through a heater, separating vapors from the heated oil, passing the vapors and oil through a cracking chamber while under pressure in counter-current paths, circulating oil from the cracking chamber through an evaporator and returning it to the cracking chamber in a closed cycle, reducing the pressure on the oil in the evaporator to remove vapors therefrom, separating carbon and heavy tarry material from the oil of the evaporator before returning it to the cracking chamber.

6. A continuous process of cracking oil comprising circulating oil in a closed cycle circuit, cracking the oil by distillation under a high pressure and temperature in one portion of the circuit, distilling the residual oil from said cracking by evaporating it under a reduced pressure in another portion of the circuit, and separately collecting condensate from the distillations in the different portions of the circuit.

7. A continuous process of cracking oil comprising circulating oil in a closed cycle circuit, cracking the oil by distillation under a high pressure and temperature in one portion of the circuit, evaporating the residual oil from said cracking by distillation of the oil under reduced pressure in another portion of the circuit, preheating oil under pressure, and inserting it into the cracking portion of the circuit and separately collecting condensates from the distillations in the different portions of the circuit.

8. A continuous process of cracking oil comprising circulating oil in a closed cycle circuit, cracking oil by distilling at a high pressure and temperature in one portion of the circuit, evaporating the residual oil from said cracking by distillation under reduced pressure in another portion of the circuit, preheating oil under pressure and inserting it into the cracking portion of the circuit, separately collecting the condensate from the distillations in the different portions of the circuit, and adding the condensate from the evaporation to the untreated oil being preheated.

9. The continuous process of cracking oil comprising circulating oil in a closed cycle circuit, cracking the oil by distilling it under a high pressure and temperature in one portion of the circuit, evaporating the residual oil from said cracking in another portion of the circuit in stages by reducing the pressure of the oil in each stage, separately condensing the vapors formed in each stage of the evaporation, preheating the oil to be cracked and adding the evaporation condensates thereto, and inserting the preheated oil condensate mixture into the cracking portion of the circuit.

10. A continuous process of cracking oil comprising circulating oil in a closed cycle circuit, cracking the oil by distillation under a high pressure and temperature in one portion of the circuit, evaporating the residual oil from said cracking by distillation under a reduced pressure in another portion of the circuit, separately collecting condensates obtained from the distillations in the different portions of the circuit, introducing oil into the cracking portion of the circuit, and applying heat only to the oil being introduced into the cracking portion of the circuit.

11. A process of treating higher boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom, comprising passing residual oil as a series of separate bodies through a cracking chamber, the temperature of the bodies increasing in the direction of flow, increasing the pressure of the oil on the bodies successively in the direction of flow of oil, introducing highly heated and relatively fresh oil into the highest temperature body, passing vapors through the bodies in a path countercurrent to the flow of oil through the bodies, and removing and condensing vapors leaving the lowest temperature body.

12. A process of treating higher boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom comprising passing oil in succession through a series of compartments of a cracking chamber, increasing the pressure of the oil in each of the succeeding compartments heating the oil to be treated under pressure and introducing it into the compartment having highest temperature, passing the vapors formed in the oil through the bodies of the oil in the compartments in a path countercurrent to the circulation of the oil therethrough, and condensing the vapors leaving the last compartment chamber.

13. A process of treating high boiling hydrocarbons to produce lower boiling point hydrocarbons therefrom comprising passing oil as an upright column through a series of compartments of a cracking chamber in succession, supplying oil to the top of each compartment, heating oil to be treated under pressure, separating vapors from the heated oil and introducing them at the bot-

tom of the oil column in the highest temperature compartment, and circulating the vapors formed in the compartments through the oil in the compartments in succession in a path countercurrent to the path of flow of oil through the compartment, reducing the pressure of the oil in each of the compartments in succession in the direction of flow of the vapors, and condensing vapors leaving the top compartment of the chamber.

14. A process of treating high boiling point hydrocarbons to produce lower boiling point hydocarbons therefrom comprising passing oil in succession through a series of compartments of a cracking chamber, heating oil to be treated under pressure and introducing it into the highest temperature compartment, increasing the pressure and temperature of the oil in each compartment in succession, circulating residue oil from the highest temperature compartment through an evaporator, removing by condensation the lower boiling point constituents in the evaporator by reducing the pressure on the oil, returning the evaporator oil residue while hot to the lowest temperature compartment of the chamber, and condensing vapors leaving the lowest temperature compartment of the chamber.

15. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom comprising passing oil in succession through a series of compartments of a cracking chamber, heating the oil to be treated under pressure, and introducing it into the highest temperature compartment, increasing the pressure and temperature of the oil in each compartment in succession, circulating residue oil from the highest temperature compartment through a series of evaporating compartments in succession, reducing the pressure of the oil in each evaporating compartment in succession, separately condensing the vapors formed in each compartment by heat interchange with incoming untreated oil, and adding the condensates to the untreated oil.

16. A process of treating high boiling point hydrocarbons to produce lower boiling point hydrocarbons therefrom comprising passing oil as an upright column in succession through a series of compartments of a cracking chamber, maintaining successively higher temperatures and pressures in each of the successive compartments, supplying oil from the bottom of one compartment to the top of the succeeding compartment, heating oil to be treated under pressure, separating vapors therefrom and introducing them at the bottom of the highest temperature compartment, introducing the heated oil at the top of the highest temperature compartment, passing the vapors through the compartments in succession countercurrent to the direction of the flow of oil therethrough, condensing vapors leaving the lowest temperature compartment, circulating oil residue from the highest temperature compartment through an evaporator, condensing the vapors formed in the evaporator and returning the oil residue from the evaporator to the lowest temperature compartment of the cracking chamber.

17. An oil distilling apparatus comprising a pipe still, a vapor separator connected to the still, a cracking chamber having a series of compartments, conductors for leading oil and means for leading vapors from one compartment to the next, means in said conductors for controlling the flow of oil and vapors through the compartments, means for leading oil and means for leading vapors from the separator to the first compartment of the cracking chamber, in the direction of the flow of the vapors, and a condenser connected to the last compartment of the cracking chamber in the direction of flow of the vapors.

18. An oil distilling apparatus comprising a cracking chamber having a series of compartments, conductors for leading oil and vapors from one compartment to the next, means in the conductors for controlling the pressures within the compartment, an evaporator having a series of compartments, means for conducting oil from one evaporating compartment to the next, means for controlling the pressure in each evaporator compartment, means to conduct residue oil from the first compartment of the cracking chamber to the first compartment of the evaporator, means to conduct residue oil from the last compartment of the evaporator to the last compartment of the cracking chamber, a condenser connected to the last compartment of the cracking chamber, and means to heat oil passing through the cracking chamber.

19. An oil distilling apparatus comprising a cracking chamber, a pipe still connected to the chamber, means to force oil under pressure through the pipe still into the chamber, an evaporator having a series of connected compartments, means for controlling the pressure in each compartment, a connection between the first compartment and the cracking chamber, a condenser connected with each compartment, means to conduct oil through the condensers in a path countercurrent to the path of flow of oil through the compartments, means for controlling the vapor pressure on the condensers, and a condenser connected with the cracking chamber.

20. An oil distilling apparatus comprising a cracking chamber, a pipe still connected with the cracking chamber, an evaporator

having a series of connected compartments, means for controlling the pressure in each compartment, a connection between the cracking chamber and the first compartment, a condenser connected with each compartment, means to conduct oil through the condensers in succession, and introduce it into the pipe still, means for controlling the vapor pressure in the condensers, means to introduce condensate from the condensers into the oil circuit passing to the pipe still, and a condenser connected with the cracking chamber.

21. An oil distilling apparatus comprising a pipe still, a cracking chamber, means for forcing oil from the pipe still into the cracking chamber, an evaporator connected with the cracking chamber, a condenser connected with the evaporator, means to conduct condensate to the pipe still, a conductor for leading oil from the evaporator back to the cracking chamber, and a condenser connected with the cracking chamber.

22. An oil distilling apparatus comprising a pipe still, a cracking chamber, means for forcing oil from the pipe still into the cracking chamber, an evaporator, means for leading oil from the cracking chamber to the evaporator, means for conucting residue from the evaporator back to the cracking chamber, a condenser connected with the cracking chamber, and means in the connection between the pipe still and the cracking chamber and between the evaporator and the cracking chamber for removing carbon and heavy residues from the oil flowing therethrough.

In testimony whereof I affix my signature.

HENRY L. DOHERTY.

having a series of connected compartments, means for controlling the pressure in each compartment, a connection between the cracking chamber and the first compartment, a condenser connected with each compartment, means to conduct oil through the condensers in succession, and introduce it into the pipe still, means for controlling the vapor pressure in the condensers, means to introduce condensate from the condensers into the oil circuit passing to the pipe still, and a condenser connected with the cracking chamber.

21. An oil distilling apparatus comprising a pipe still, a cracking chamber, means for forcing oil from the pipe still into the cracking chamber, an evaporator connected with the cracking chamber, a condenser connected with the evaporator, means to conduct condensate to the pipe still, a conductor for leading oil from the evaporator back to the cracking chamber, and a condenser connected with the cracking chamber.

22. An oil distilling apparatus comprising a pipe still, a cracking chamber, means for forcing oil from the pipe still into the cracking chamber, an evaporator, means for leading oil from the cracking chamber to the evaporator, means for conucting residue from the evaporator back to the cracking chamber, a condenser connected with the cracking chamber, and means in the connection between the pipe still and the cracking chamber and between the evaporator and the cracking chamber for removing carbon and heavy residues from the oil flowing therethrough.

In testimony whereof I affix my signature.

HENRY L. DOHERTY.

DISCLAIMER

1,597,674.—*Henry L. Doherty*, New York, N. Y. DISTILLATION OF OIL. Patent dated August 31, 1926. Disclaimer filed March 8, 1934, by the assignee, *Doherty Research Company*.

Hereby disclaims:

(*a*) From claims 6 and 10 of said Letters Patent, any process in which oil in the closed cycle circuit is subjected to heat otherwise than through previously heated oil which is introduced to the circuit.

(*b*) From claim 21, any apparatus in which the conductor for leading oil from the evaporator back to the cracking chamber is connected to the pipe still.

[*Official Gazette March 27, 1934.*]

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