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ART OF REFINING HYDROCARBONS

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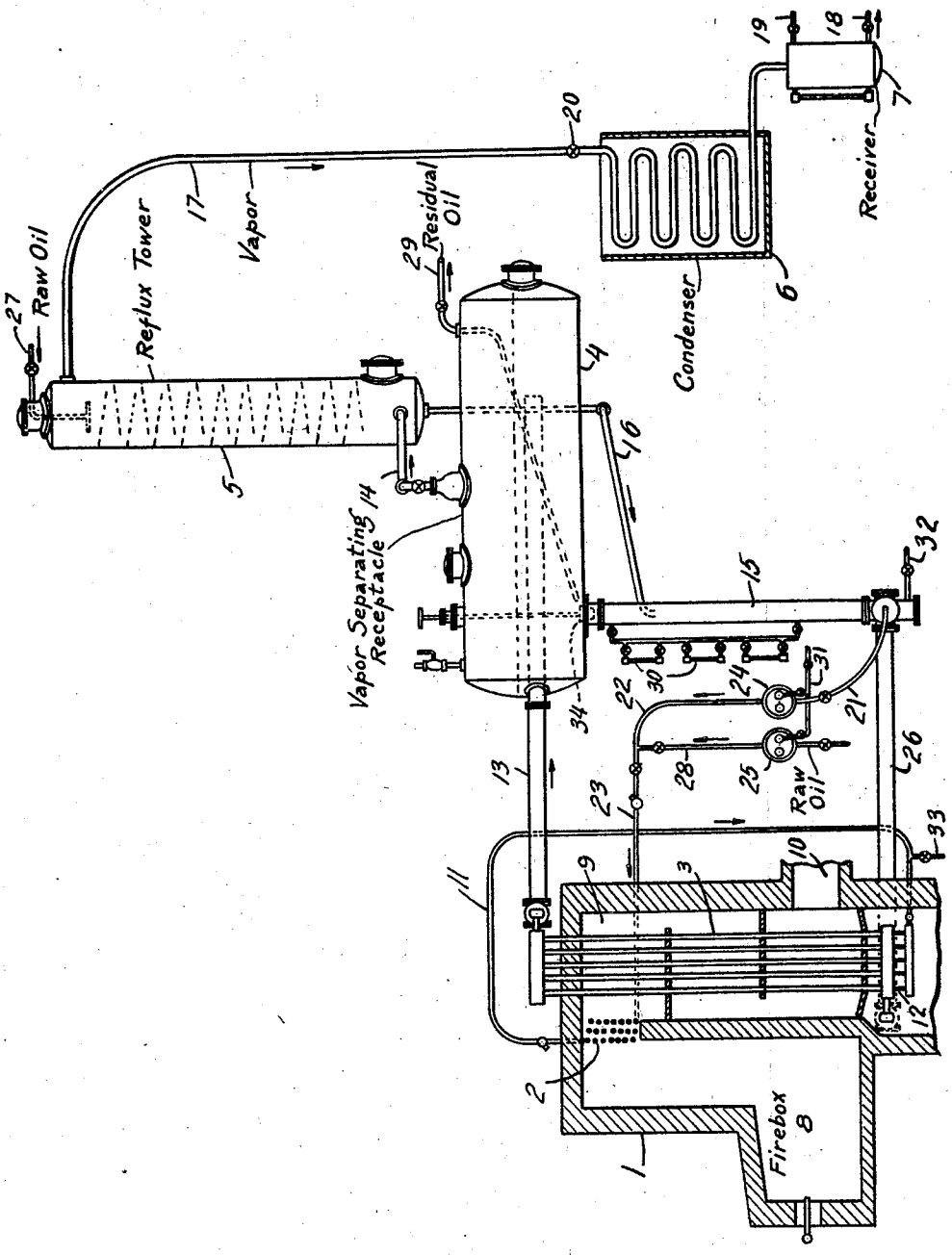

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ART OF REFINING HYDROCARBONS

Application filed May 1, 1929. Serial No. 359,451.

This invention relates to improvements in cracking higher boiling hydrocarbon oils, such as gas oil, for the production of lower boiling hydrocarbon oils, such as gasoline, by pressure distillation. In certain aspects, this invention relates to improvements in the operation described in an application filed by Eugene C. Herthel, September 24, 1923, Serial No. 664,502.

This invention provides a simplified operation, and a more easily controlled operation, in which oil free from tar constituents produced by cracking is subjected to more severe cracking conditions while oil including accumulating tar constituents produced by cracking is subjected to less severe cracking conditions or, conversely, in which heating gases for supplying heat to the cracking operation are first brought in heat exchanging relation with oil free from tar constituents produced by cracking and then in heat exchanging relation with oil including accumulating tar constituents produced by cracking.

According to the present invention, vapors are taken off under superatmospheric pressure from a body of oil maintained at a cracking temperature in a vapor separating receptacle and subjected to a refluxing operation, the reflux condensate so produced is forced first through a long heating element of small cross section and then through a shorter heating element of larger cross section, the oil is subjected to more severe cracking conditions in the long heating element of small cross section and to less severe cracking conditions in the shorter heating element of larger cross section, the hot oil products from the last heating element are discharged into the vapor separating receptacle and a distillate product is condensed from the vapors escaping from the refluxing operation. The two heating elements are advantageously arranged in a common heating furnace so that the heating gases pass first over the long heating element of small cross section and then over the shorter heating element of larger cross section so that the oil is subjected to more severe cracking conditions in the first mentioned heating element and to less severe cracking conditions in the second mentioned heating element and so that the heating gases are tempered by the first heat exchange before the second heat exchange. To promote a stable condition of circulation an auxiliary supply of reflux condensate from the refluxing operation is advantageously permitted to flow through the shorter heating element of larger cross section with the hot oil products from the long heating element of small cross section. Unvaporized oil is not permitted to flow from the vapor separating receptacle through the heating elements.

A number of advantages are thus secured. Simplicity of operation and ease of control, as previously noted, are important advantages of the invention.

The invention will be further described in connection with the accompanying drawings which illustrate, diagrammatically and conventionally, in elevation and partly in section and with parts broken away, one form of apparatus adapted for use in carrying out the process of the invention. It will be understood that the process of the invention may be carried out in other and different forms of apparatus; the apparatus illustrated in the drawings is one advantageous form of apparatus for this purpose.

The pressure still system illustrated comprises a heating furnace 1 having two heating elements 2 and 3 arranged therein, a drum 4, a reflux tower 5, a condenser 6, a receiver 7 and connections including appropriate pumps between the several parts of the apparatus, and for supplying raw stock thereto and for discharging the products of the operation. The heating furnace 1 comprises a fire-box 8 communicating through a heating flue 9 with a stack flue 10. The heating element 2 is arranged between the upper end of the heating flue 9 and the firebox 8 so that the heating gases pass first over it while at maximum temperature. The heating element 3 is arranged in the heating flue 9 so that the heating gases pass over it after passing over the heating element 2 while at lower temperature. The heating element 2 may comprise, for example, forty 2″ tubes connected in series and the heating element 3 may com-

prise, for example, fifty 4″ tubes connected in parallel. Hot oil products from the heating element 2 are discharged through connection 11 into the lower ends of the tubes of the heating element 3 through a corresponding series of jet pipes 12 projecting for a short distance into the lower ends of these tubes. Hot oil products from the heating element 3 are discharged through connection 13 into the drum 4, this drum constituting in normal operation a vapor separating receptacle. Vapors escape from the drum 4 through connection 14 to the lower end of the reflux tower 5. Higher boiling components of these vapors are condensed in the reflux tower 5 and the condensate is supplied to the leg 15 through connection 16. Vapors escape from the upper end of the reflux tower 5 through connection 17 to condenser 6 arranged to discharge into receiver 7. The condensed distillate product is discharged from receiver 7 through connection 18, uncondensed vapors and gases being discharged through connection 19. Pressure in the system is maintained and regulated by means of valve 20 in the connection 17 between the reflux tower 5 and the condenser 6 or by means of suitable valves arranged beyond the condenser or the receiver. Reflux condensate, or an oil mixture including reflux condensate, is supplied from leg 15 through connections 21, 22 and 23 by means of pump 24 to the heating element 2. This oil is also supplied to the lower ends of the tubes forming the heating element 3 through connection 26. The jet pipes 12 are so arranged within the lower ends of the tubes of the heating element 3 as to operate to tend to maintain circulation of an auxiliary supply of oil from the leg 15 through the heating element 3 to the drum 4. Connections 27 and 28 are provided for supplying raw oil to the system during operation and connection 29 is provided for discharging residual unvaporized oil from the drum 4 during operation. A series of level gauges 30 are provided for determining the liquid level, if any, in the leg 15. Connection 31 is provided for supplying oil to and through the bearings of the pumps 24 and 25. At the beginning of a run the system is initially charged through connection 32 and at the end of a run the system is pumped out through connections 32 and 33. Valve 34, normally closed, is provided for use in bringing the system to operating conditions.

The pumps illustrated, designated 24 and 25, are described in more detail in Letters Patent No. 1,701,198 issued February 5, 1929, to the Sinclair Refining Company, on an application of Thomas de Colon Tifft. The valve 34 may be of the construction and arrangement described in more detail in an application of Eugene C. Herthel, filed January 12, 1928, Serial No. 246,263.

In bringing the system illustrated to operating conditions, for example, the system is initially charged with oil through connection 32, gas oil for example, the valve 34 being open and the pump 24 being in operation, the fires are then started in the firebox 8, drips are taken off, pressure is built up to the desired value by closing the valve 20, the valve 20 is then gradually opened to maintain this value and the supply of raw oil and discharge of residual oil are begun, and the valve 34 is closed. While the valve 34 is open, during the initial period of operation, circulation of the still charge from the drum 4 through the heating element 3 back to the drum 4 is maintained by thermal action aided by the jets of oil from the heating element 2 discharged into the lower ends of the tubes forming the heating element 3.

For the production of gasoline from gas oil, for example, the system may be operated under a pressure in the neighborhood of 125–150 pounds per square inch, or higher or lower pressures may be used. In general, higher pressures are advantageous in running lower boiling charging stocks and lower pressures may be used in running higher boiling charging stocks.

Once brought to operating conditions, the operation is continued with the supply of raw stock and the discharge of residual stock as the desired distillate product is taken off. Raw oil may be supplied through connection 27 or through connection 28 or through both of these connections. Raw oil may be supplied through connection 27, for example, at a rate regulated to condense in the reflux tower 5 those constituents higher boiling than suitable as components of the desired distillate product in which case the oil flowing from the reflux tower 5 to the leg 15 through connection 16 comprises a mixture of reflux condensate and unvaporized raw oil. Any additional oil required may be supplied through connection 28; for example, if the oil level in leg 15 drops too low for the maintenance of adequate circulation additional raw oil is supplied through connection 28. Or the vapors in the reflux tower 5 may be otherwise cooled for condensation of higher boiling constituents and all of the raw oil supplied to the operation supplied through connection 28.

In operation, circulation of oil through the heating element 2 is maintained by the positive action of the pump 24. The pressure through the leg 15, the heating element 3, the drum 4 and the reflux tower 5 being the same during normal operation, except for the relatively small pressure differentials required to maintain circulation through connections 26, 13, 14, and 16, the action of the jet pipes 12 is adequate to maintain circulation through the heating element 3. In the system illustrated, moreover, the operation

of these jet pipes is largely self-governing; an increase in pressure in the heating element 3 tends to decrease circulation through connection 26 and a decrease in the pressure in the heating element 3 tends to increase circulation through connection 26. In the furnace 1, the heating gases first, and while at highest temperature, pass over the heating element 2 through which oil free from tar constituents produced by cracking, reflux condensate or a mixture of reflux condensate and raw oil, is circulating and then, having been tempered by this first heat exchange, pass over the heating element 3 through which oil including any tar constituents produced in the heating element 2 is circulating. Relatively high velocity of flow is maintained through the heating element 2 as compared to the relatively low velocity of flow maintained through the heating element 3. The oil circulating through the heating elements is thus subjected to severe cracking conditions but under conditions tending to minimize any separation or deposition of tarry or carbonaceous material in this heating element and then, in circulating through the heating element 3, to less severe cracking conditions for a further period. The auxiliary supply of reflux condensate from the leg 15 to the heating element 3 also tends to minimize any tendency towards separation or deposition of tarry or carbonaceous material in the heating element 3.

In the system illustrated, the drum 4, the leg 15, the reflux tower 5, and the connections 26, 13, 21, 22, 23, 14, 16 and 11 are with advantage lagged or thermally insulated.

I claim:

1. In cracking higher boiling hydrocarbon oils for the production of lower boiling hydrocarbon oils by pressure distillation, the improvement which comprises taking off vapors under superatmospheric pressure from a body of oil maintained at a cracking temperature in a vapor separating receptacle and subjecting these vapors to a refluxing operation, forcing reflux condensate from said refluxing operation first through a long heating element of small cross section and then through a shorter heating element of larger cross section without permitting unvaporized oil to flow from said vapor separating receptacle through said heating elements, permitting an auxiliary supply of reflux condensate from said refluxing operation to flow through the second mentioned heating element with the hot oil products from the first mentioned heating element, passing heating gases first over the first mentioned heating element and then over the second mentioned heating element whereby the oil is subjected to more severe and to less severe cracking conditions in said heating elements respectively, discharging the hot oil products from the second mentioned heating element into said vapor separating receptacle and condensing a distillate product from vapors escaping from said refluxing operation.

2. In cracking higher boiling hydrocarbon oils for the production of lower boiling hydrocarbon oils by pressure distillation, the improvement which comprises taking off vapors under superatmospheric pressure from a body of oil maintained at a cracking temperature in a vapor separating receptacle and subjecting these vapors to a refluxing operation, forcing reflux condensate from said refluxing operation first through a long heating element of small cross section and then through a shorter heating element of larger cross section without permitting unvaporized oil to flow from said vapor separating receptacle through said heating elements, permitting an auxiliary supply of reflux condensate from said refluxing operation to flow through the second mentioned heating element with the hot oil products from the first mentioned heating element, subjecting the oil to more severe cracking conditions in the first mentioned heating element and to less severe cracking conditions in the second mentioned heating element, discharging the hot oil products from the second mentioned heating element into said vapor separating receptacle and condensing a distillate product from vapors escaping from said refluxing operation.

In testimony whereof I affix my signature.

WILLIAM VAUGHN ISCHIE.