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ART OF CRACKING HYDROCARBONS

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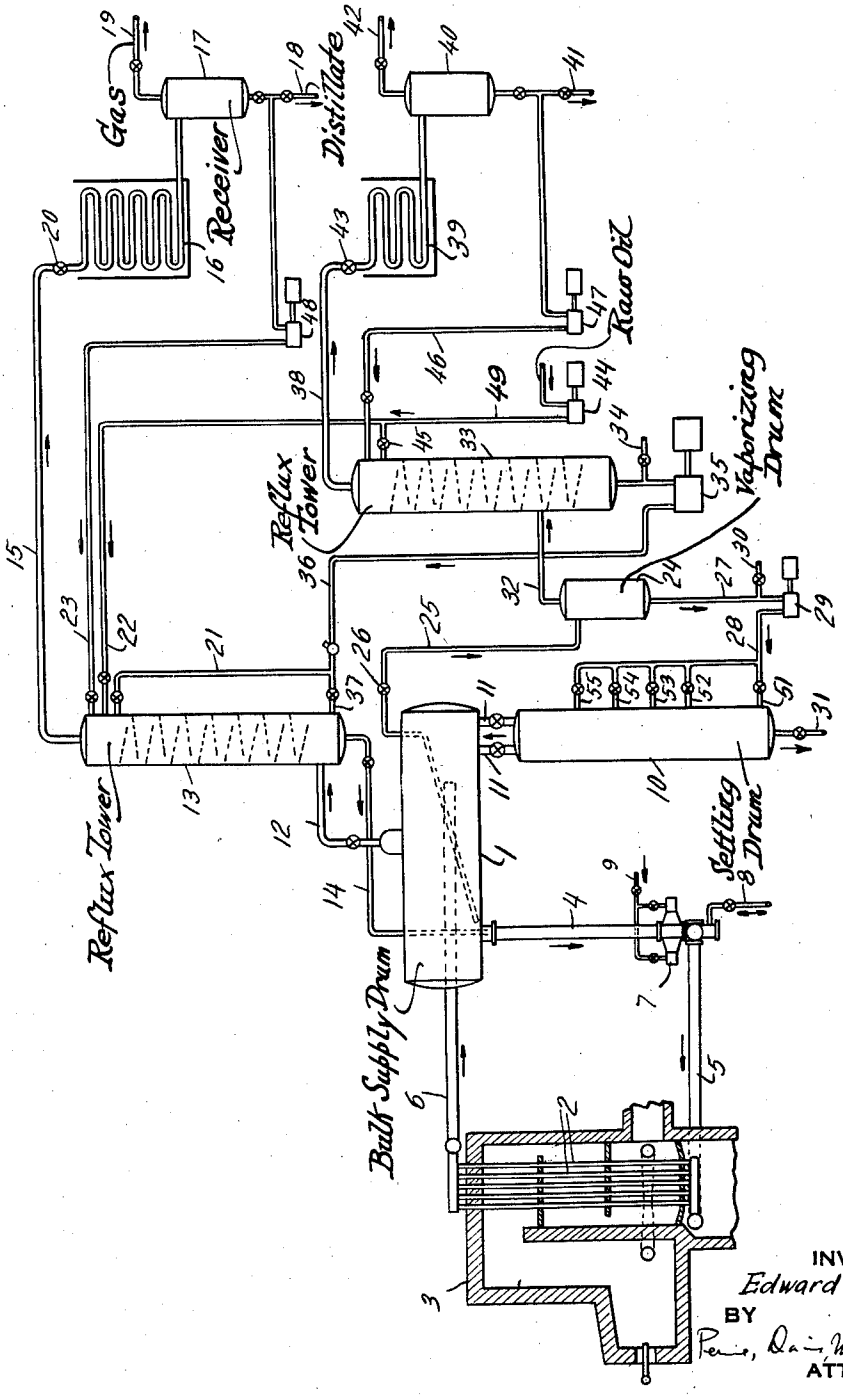

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UNITED STATES PATENT OFFICE

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ART OF CRACKING HYDROCARBONS

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This invention relates to improvements in the manufacture of lower boiling hydrocarbon oils, such as gasoline, from higher boiling hydrocarbon oils, such as gas oil, by pressure distillation cracking operations.

Pressure distillation operations have, in the past, been carried out both as batch operations and as continuous operations, the operation being made continuous by the supply of raw stock and the discharge of residual stock during operation. The batch operation, without the discharge of residual stock during the operation, makes possible a higher yield of lower boiling products than the continuous operation, that is the batch operation makes possible the recovery of a larger proportion of lower boiling oil from a given quantity of higher boiling oil. On the other hand, the continuous operation makes possible a longer period of uninterrupted operation and consequently makes possible the cracking of a larger amount of raw stock in a given apparatus over a given period of time, making possible in many cases the production of a larger amount of lower boiling products in a given period of time although this larger amount may represent a smaller proportion of the raw stock. As will be apparent, the merits of the two types of operation are determined, at least in part, by the economic conditions prevailing at the time.

The present invention provides an improved method of operation which, within limits, combines the advantages of both methods of operation, affording higher yields as compared to continuous operations and affording prolonged periods of uninterrupted operation as compared to batch operations.

The products of pressure distillation cracking operations include, in addition to the desired lower boiling hydrocarbon oils, pitchy constituents which, under some conditions, undergo further decomposition forming coke or coke-like constituents. The deposit of pitchy or cokey constituents upon heating surfaces through which heat is transferred to the oil in pressure distillation cracking operations is one of the major difficulties involved in such operations. Such difficulties may be controlled as described, for example, in Letters Patent No. 1,598,136 issued to the Sinclair Refining Company, August 31, 1926, on the application of Eugene C. Herthel, but this method of operation, as any other method of operation involving the discharge of oil components of the charge of oil undergoing cracking, involves a lowering of the yield of lower boiling products. Difficulties due to deposition of pitchy or cokey constituents produced by the cracking operation are increased where, for example, finely divided absorbent agents or finely divided desulphurizing agents are added to the charge of oil to secure some other benefit.

The present invention provides for concentration within the pressure distillation system of pitchy or cokey constituents produced by the cracking operation, and of any added solids or semi-solids or the reaction products of such additions, and for the separation from such concentrated objectionable constituents, but within the system, of a maximum of those oil components associated therewith.

In carrying out the present invention, a charge of high boiling oil is heated to a cracking temperature by circulation over externally fired heating surfaces while taking off vapors including vapors of the desired low boiling product therefrom under superatmospheric pressure, the high boiling oil forming this heated charge is circulated successively through a zone of reduced pressure and then through a zone of reduced turbulence, the zone of reduced turbulence being maintained in free communication with that part of the charge circulating over the externally fired heating surfaces and under the first mentioned superatmospheric pressure, vapors are taken off from the zone of reduced pressure and pitchy and cokey constituents are thus concentrated in the residual oil therein, a further concentration of such pitchy and cokey constituents as effected within the zone of reduced turbulence, and raw high boiling oil is supplied to the charge of oil to maintain the charge as the operation proceeds. The vapors taken off from the zone of reduced pressure are with advantage

condensed and such condensate returned to the charge of high boiling oil.

The operation may be carried out without discharge of any residual product from the system during the operation. Concentrated pitchy and cokey constituents may, however, be periodically discharged from the zone of reduced turbulence as the operation proceeds to prolong the period of uninterrupted operation.

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 carrying out the method of operation of the invention.

The pressure still illustrated in the drawings is of the general type described in Letters Patent No. 1,285,200 issued to the Sinclair Refining Company November 19, 1918, on my application. This pressure still comprises a bulk supply drum 1, a battery of heating tubes 2 arranged in the heating flue of a heating furnace 3, and circulating connections 4, 5 and 6 including a circulating pump 7 for circulating oil from the bulk supply drum through the heating tubes and back to the bulk supply drum. Connection 8 is provided for initially charging the still at the beginning of a run and for pumping out the still at the end of a run. Connection 9 is provided for supplying cooling oil to and through the bearings of the circulating pump, as described in Letters Patent No. 1,676,202, issued to the Sinclair Refining Company, July 3, 1928, on the application of myself and the late John E. Bell. This pressure still also comprises a settling drum 10 in free communication with the bulk supply drum 1 through connections 11.

The vapors from the bulk supply drum 1 escape through connection 12 to the lower end of reflux tower 13. The condensate from the reflux tower 13, together with any admixed unvaporized stock introduced into the reflux tower 13, is returned to the pressure still charge through connection 14. The vapors remaining uncondensed escape from the upper end of the reflux tower 13 through connection 15 to condenser 16. This condenser discharges into receiver 17 from which the condensed distillate product is discharged 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 between the reflux tower 13 and the condenser 16 or by means of suitable valves arranged beyond the condenser 16 or the receiver 17. Condensation within the reflux tower 13 is controlled by the regulated introduction of one or more refluxing media through one or more of the connections 21, 22 and 23.

The high boiling oil forming the still charge is circulated, during the operation, through vaporizing drum 24 and settling drum 10, the oil flowing from the bulk supply drum 1 to the vaporizing drum 24 through connection 25 including pressure reducing valve 26 and the residual oil being forced from vaporizing drum 24 to the settling drum 10 through connections 27 and 28 by means of pump 29 and thence back to the bulk supply drum 1 through connections 11. Connection 30 is provided for pumping out the vaporizing drum 24 or for use in an emergency. Connection 31 is provided for pumping out the settling drum 10 or for periodically discharging concentrated pitchy and cokey constituents therefrom.

Vapors separated in the vaporizing drum 24 escape through connection 32 to the lower end of reflux tower 33. The condensate from the reflux tower 33 is either discharged or in part discharged through connection 34 or returned or in part returned to the still charge through reflux tower 13 by means of pump 35 and through connection 36 and either connection 37 or connection 21. Vapors remaining uncondensed escape through connection 38 to condenser 39. This condenser discharges into receiver 40 from which condensate is discharged through connection 42. Pressure in the reflux tower 33 and the vaporizing drum 24 may be maintained or regulated by means of valve 43 or by means of suitable valves arranged beyond the condenser or the receiver.

Raw oil is supplied through connection 49 by means of pump 44 and introduced either into the upper end of reflux tower 33 through connection 45 and thence into reflux tower 13 or into the upper end of reflux tower 13 through connection 22. The operation of either or both of the reflux towers 13 and 33 may thus be controlled by the regulated introduction of raw oil. The operation of either or both of these reflux towers may also be controlled, or control of the operation supplemented, by the regulated introduction of a part of the fraction condensed from the vapors escaping from the tower, through connection 46 by means of pump 47 in the case of tower 33 and through connection 23 by means of pump 48 in the case of tower 13.

The bulk supply drum 1, the circulating connections 4, 5 and 6, the vaporizing drum 24, the settling drum 10, the connections 25, 27 and 28, the reflux towers 13 and 33, and connections 12, 14, 32 and 36 are with advantage lagged or thermally insulated.

In carrying out the invention in the apparatus illustrated, pitchy or cokey constituents are with advantage concentrated in the high boiling oil circulating through the vaporizing drum to a maximum permitting maintained circulation of the concentrate through the still system and particularly through the connections between the vaporiz-

ing drum and the settling drum 10. This concentration is controlled by controlling the vaporization in the vaporizing drum 24 in turn controlled by regulating the pressure maintained in the vaporizing drum 24 and consequently the pressure differential between the bulk supply drum 1 and the vaporizing drum 24, the vaporization in the vaporizing drum 24 being effected by this pressure differential. In carrying out the invention in the apparatus illustrated for the manufacture of gasoline from gas oil, for example, the pressure in the bulk supply drum may be maintained in the neighborhood of 100–300 pounds per square inch and the pressure in the vaporizing drum in the neighborhood of 5–50 pounds per square inch, the circulating charge of oil in the pressure still system being heated in the heating tubes to a temperature corresponding to the pressure maintained in the bulk supply drum or to a somewhat higher temperature, and the operation of the reflux towers 13 and 33 may be regulated to maintain the temperature of the vapors escaping therefrom in the neighborhood of 375–475° F. and 350–425° F. respectively.

Connection 28 communicates with the settling drum 10 through a series of valved connections 51, 52, 53, 54 and 55. These are provided to permit the progressive accumulation of a concentrate of pitchy and cokey constituents in the settling drum 10 as the operation proceeds without interfering with circulation of the high boiling oil forming the pressure still charge through the vaporizing drum 24 and the settling drum 10 until the drum 10 is filled with such concentrate to a point such that it no longer operates to provide a zone of reduced turbulence. The still is then shut down for cleaning. Or, if this concentrate is being periodically discharged from the settling drum 10, the accumulated concentrate is discharged from the drum 10 somewhat before this point is reached and the operation continued. Such periodic discharge of concentrated pitchy and cokey constituents is limited to a volume such that the consequent lowering of the liquid level in the bulk supply drum 1 does not interfere with circulation of the pressure still charge through the heating tubes. Operating without periodic discharge of concentrated pitchy and cokey constituents, the period of operation is determined, in large measure, by the capacity of the settling drum 10, together with the concentration effected in the vaporizing drum 24.

High boiling oil may be circulated through connection 25, for example, at a rate approximating 40–70% of the rate at which raw oil is supplied through connection 49, where the condensate mixture from the tower 33 is returned to the pressure still through reflux tower 13, and the vaporization in vaporizing drum 24 may be regulated so that the concentrate is formed therein at a rate approximating 5–15% of the rate at which raw oil is supplied through connection 49, the foregoing comparisons being by volume at standard temperature.

I claim:

1. In cracking higher boiling hydrocarbon oils to produce lower boiling hydrocarbon oils, the improvement which comprises heating a charge of high boiling oil to a cracking temperature by circulation over externally fired heating surfaces while taking off vapors including vapors of the desired low boiling product therefrom under superatmospheric pressure, circulating high boiling oil from said charge through a zone of reduced pressure and then by increasing the pressure on the oil through a zone of reduced turbulence maintained under the first mentioned superatmospheric pressure and in free communication with the charge circulating over the first mentioned heating surfaces, taking off vapors from said zone of reduced pressure whereby pitchy and cokey constituents are concentrated in the residual oil and effecting a further concentration of such pitchy and cokey constituents in the residual oil within said zone of reduced turbulence, and supplying raw high boiling oil to the charge of high boiling oil to maintain the charge as the operation proceeds.

2. In cracking higher boiling hydrocarbon oils to produce lower boiling hydrocarbon oils, the improvement which comprises heating a charge of high boiling oil to a cracking temperature by circulation over externally fired heating surfaces while taking off vapors including vapors of the desired low boiling product therefrom under superatmospheric pressure, circulating high boiling oil from said charge through a zone of reduced pressure and then by increasing the pressure on the oil through a zone of reduced turbulence maintained under the first mentioned superatmospheric pressure and in free communication with the charge circulating over the first mentioned heating surfaces, taking off vapors from said zone of reduced pressure whereby pitchy and cokey constituents are concentrated in the residual oil and effecting a further concentration of such pitchy and cokey constituents in the residual oil within said zone of reduced turbulence, condensing vapors taken off from said zone of reduced pressure and returning such condensate to the charge of high boiling oil, and supplying raw high boiling oil to the charge of high boiling oil to maintain the charge as the operation proceeds.

3. In cracking high boiling hydrocarbon oils to produce lower boiling hydrocarbon oils, the improvement which comprises heating a charge of high boiling oil to a cracking temperature by circulation over externally fired heating surfaces while taking off

vapors including vapors of the desired low boiling product therefrom under superatmospheric pressure, circulating high boiling oil from said charge through a zone of reduced pressure and then by increasing the pressure on the oil through a zone of reduced turbulence maintained under the first mentioned superatmospheric pressure and in free communication with the charge circulating over the first mentioned heating surfaces, taking off vapors from said zone of reduced pressure whereby pitchy and cokey constituents are concentrated in the residual oil and effecting a further concentration of such pitchy and cokey constituents in the residual oil within said zone of reduced turbulence, periodically discharging concentrated pitchy and cokey constituents from said zone of reduced turbulence as the operation proceeds, and supplying raw high boiling oil to the charge of high boiling oil to maintain the charge as the operation proceeds.

In testimony whereof I affix my signature.

EDWARD W. ISOM.