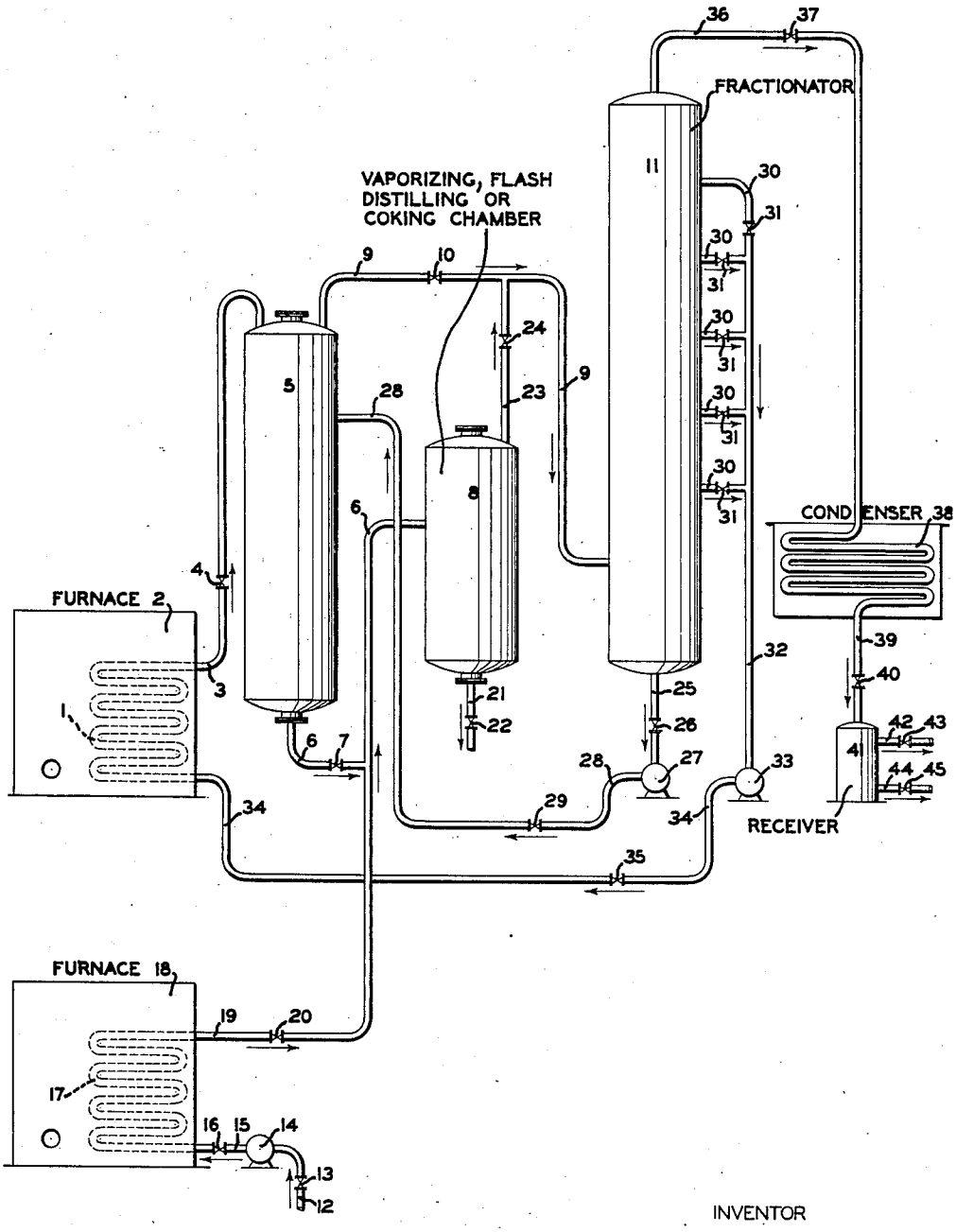
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CONVERSION OF HYDROCARBON OILS

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INVENTOR

MARION W. BARNES

BY Frank L. Belknap

ATTORNEY

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CONVERSION OF HYDROCARBON OILS

Marion W. Barnes, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill., a corporation of Delaware

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This invention relates to the conversion of hydrocarbon oils and more particularly refers to an improved process and apparatus especially adapted to the conversion of relatively heavy oils to produce maximum yields of light distillate products, such as motor fuel of high anti-knock value, and a residual product of controlled quality.

In cracking processes wherein the raw oil charging stock is subjected to conversion in the same heating coil with lighter insufficiently converted intermediate products of the operation milder conversion temperatures must be utilized when the charging stock is of relatively heavy nature, than the conversion temperature best suited for the treatment of the reflux condensate (intermediate conversion products), in order to prevent the excessive formation and deposition of coke in the heating coil. Furthermore, in the type of process now in favor wherein the residual products formed under high superatmospheric pressure are subjected to flash distillation at reduced pressure for further vaporization and wherein reflux condensate from the flashed vapors is returned to the heating coil of the system together with reflux condensate from the cracked vapors, the combined reflux condensates often contain small amounts of heavy residual material which have been carried over with the vapors from the flash distilling chamber, which contaminating material in the reflux is especially susceptible to coking under the conditions employed in the heating coil and often leaves a deposit of carbon on the walls of the heating tubes, which necessitates short operating periods and prolonged clean-out time.

By use of the novel features of the present invention the above mentioned troubles are eliminated as neither the raw oil charging stock or the heavy components of the reflux condensate pass through the high temperature heating coil wherein the lighter reflux condensate is subjected to further conversion. This practice permits the use of more severe conversion conditions, to which said light reflux condensate is best suited, without encountering coking difficulties and yet also permits the desired degree of conversion for both the raw oil charging stock and the heavy components of the reflux condensate.

In one of its specific embodiments the invention may comprise subjecting vapors resulting from the conversion of hydrocarbon oil and subsequent flash distillation of the residual liquid conversion products to fractionation whereby the components of the vapors boiling above the end boiling point of the desired final light product of the system are condensed and separated into a heavy fraction, containing any coke-forming residual material carried over with the vapors from the flash distilling operation, and lower boiling fractions, subjecting said lower boiling fractions of the reflux condensate to conversion temperature at superatmospheric pressure in a heating coil and communicating reaction chamber, returning said heavy components of the reflux condensate directly to the reaction chamber, subjecting residual liquid from the reaction chamber to further vaporization at reduced pressure, subjecting vapors from both the conversion and flash distilling operations to fractionation, as already described, subjecting raw oil charging stock for the system to independently controlled conversion conditions in a separate heating coil and introducing the heated material into the reduced pressure vaporizing chamber together with the residual liquid conversion products from the reaction chamber.

While the process of the present invention is particularly adapted to the treatment of relatively heavy charging stock such as heavy crudes, residual oil, fuel oil and the like, it may also be utilized to advantage for the treatment of lower boiling oils and is not limited to any particular type of charging stock.

The attached diagrammatic drawing illustrates one specific form of apparatus incorporating the features of the present invention. These features and the advantages will be more clearly understood by reference to the following description of the drawing.

Heating coil 1 is located within a furnace 2 of any suitable form and the oil supplied to this zone is heated to the desired conversion temperature preferably at substantial superatmospheric pressure and is discharged through line 3 and valve 4 into reaction chamber 5 which is also preferably maintained at substantial superatmospheric pressure.

Final separation of vaporous and residual liquid conversion products may or may not be accomplished in chamber 5, as desired, and the heated oil from heating element 1 may be introduced in this zone at any desired point although the drawing shows only one point of introduction. Residual liquid is withdrawn from the reaction chamber through line 6 and valve 7 to further vaporization in vaporizing or flash distilling chamber 8 and vaporous conversion products may either be withdrawn together with the residual liquid to chamber 8, in the manner described, or may be separately removed from the reaction

chamber through line 9 and valve 10 and subjected to fractionation in fractionator 11.

Raw oil charging stock for the system may be supplied through line 12 and valve 13 to pump 14 from which it is fed through line 15 and valve 16 into heating coil 17, which is located within a furnace 18 of any suitable form capable of heating the raw oil charging stock to the desired conversion temperature under the desired pressure. The heated raw oil from heating coil 17 may be discharged through line 19 and valve 20 into line 6, commingling therein with the material from chamber 5, withdrawn through this line, and passing therewith to chamber 8, or the heated raw oil may be separately introduced into chamber 8 at any desired point by well known means, not illustrated in the drawing.

Vaporizing or flash distilling chamber 8 preferably employs a substantially reduced pressure relative to that utilized in reaction chamber 5 and the residual liquid conversion products from chamber 5 are subjected to further vaporization in this zone together with the heated raw oil from heating coil 17. The process may be operated for the production of either residual liquid or a substantially non-fluid residual material such as petroleum coke or asphalt. Residual liquid or asphaltic material, when such is produced, may be withdrawn from chamber 8 through line 21 and valve 22 to cooling and storage or to any desired further treatment. When the residual product of the process is reduced to coke in chamber 8 it may be allowed to accumulate in this zone to be removed therefrom when the operation of the chamber is discontinued and, when desired, a plurality of coking zones, similar to chamber 8 but not illustrated in the drawing, may be employed and may be operated either alternately or simultaneously to provide additional space for the accumulation of coke and thus prolong the operating cycle of the process. Vaporous products are withdrawn from chamber 8 through line 23 and valve 24 to line 9 and may pass thence to fractionation in fractionator 11 together with the vaporous products, if any, withdrawn from chamber 5 through line 9 and valve 10, as already described.

The vapors supplied to fractionator 11, comprising vaporous products resulting from both the conversion and flash distillation or coking operations, are separated by fractional condensation into three major fractions. The heaviest components of the vapors, including any residual material of coke-forming characteristics carried over with the vapors from chamber 8, collect as heavy reflux condensate in the lower portion of the fractionator, are withdrawn therefrom through line 25 and valve 26 to pump 27 by means of which they are returned through line 28 and valve 29 to reaction chamber 5, entering this zone at any desired point, and being subjected therein to further conversion by direct contact with the heated materials from chamber 5. The intermediate components of the vapors, which boil above the boiling point of the desired final light product of the system, are also condensed within the fractionator and may be withdrawn as a side stream or streams of light reflux condensate through one or a plurality of lines 30 controlled by valves 31 and pass through line 32 to pump 33, by means of which they are fed through line 34 and valve 35 to heating coil 1 and comprise the only material supplied to this heating coil. The lightest components of the vapors supplied to fractionator 11, comprising materials within the boiling range of the desired final light product of the system and gas, are removed from the upper portion of the fractionator through line 36 and valve 37, are subjected to condensation and cooling in condenser 38 from which the resulting distillate and uncondensable gas passes through line 39 and valve 40 to be collected in receiver 41. Uncondensable gas may be released from the receiver through line 42 and valve 43. Distillate may be withdrawn from the receiver through line 44 and valve 45.

Any of the usual operating expedients such as recirculating a portion of the distillate from the receiver of the system to the upper portion of the fractionator to assist cooling and fractionation in this zone and preheating a portion or all of the raw oil charging stock by heat recovered from within the system may be employed without departing from the scope of the invention although such well known features are not illustrated in the accompanying drawing.

Conversion temperatures employed within the heating coil to which the light reflux condensate is supplied may range from 900 to 1050° F. or thereabouts, preferably with superatmospheric pressure of from 100 to 500 pounds, or more per square inch. Substantially this same range of pressures may be employed in the reaction chamber but the vaporizing or coking chamber as well as the succeeding fractionating, condensing and collecting portions of the system are preferably maintained at a substantially reduced pressure ranging from 100 pounds, or thereabouts, per square inch down to substantially atmospheric pressure. The heating coil to which the raw oil charging stock is supplied may utilize conversion conditions either more or less severe than those to which the light reflux condensate is subjected, depending upon the nature of the charging stock. With heavy charging stocks, such as crudes, residual oil, fuel oil and the like, a milder conversion temperature than that to which the light reflux is subjected, ranging, for example, from 800 to 950° F., may be employed in the raw oil heating coil with pressures ranging from 100 to 500 pounds, or thereabouts, per square inch. When relatively light charging stock such as gas oil, kerosene distillate, pressure distillate bottoms, naphtha, straight-run gasoline, etc., are employed, higher conversion temperatures ranging, for example, from 900 to 1100° F., may be employed in the raw oil heating coil with pressures which may range from substantially atmospheric to 800 pounds, or more, per square inch.

As a specific example of the operation of the process of the present invention, the raw oil charging stock is an 18° A. P. I. gravity mid-continent fuel oil which is subjected to a temperature of about 890° F., at a pressure of approximately 200 pounds per square inch, and is then introduced into the flash distilling chamber. Light reflux condensate from the fractionator of the system, having an end boiling point of approximately 650° F., is independently subjected to a conversion temperature of approximately 925° F., at a superatmospheric pressure of about 350 pounds per square inch and is then introduced into the reaction chamber which is maintained at about the same pressure. The vaporizing chamber is maintained at a pressure of approximately 50 pounds per square inch, which pressure is substantially equalized in the succeeding fractionating, condensing and collecting equipment. Heavy reflux condensate having an initial boiling point of about 650° F. is returned directly

to the reaction chamber. This operation may yield, per barrel of raw oil charging stock, about 55% of motor fuel having an anti-knock value equivalent to an octane number of approximately 78, about 38% of residual oil suitable for sale as fuel, the remainder being chargeable to uncondensable gas, loss and a negligible amount of coke.

I claim as my invention:

1. A cracking process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in an enlarged reaction zone, removing vapors and unvaporized oil from the reaction zone, flash distilling the unvaporized oil in a reduced pressure zone by pressure reduction, simultaneously heating charging oil for the process to conversion temperature under pressure while flowing in a restricted stream through a heating zone and then discharging the same directly into the reduced pressure zone, removing vapors from the reduced pressure zone, fractionating the last-named vapors and the vapors removed from the reaction zone and separating therefrom a relatively heavy reflux and a lighter reflux, introducing the heavy reflux directly to the reaction zone, heating the lighter reflux to cracking temperature in a second heating zone and thence discharging the same into the reaction zone, and finally condensing the fractionated vapors.

2. A cracking process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in an enlarged reaction zone, removing vapors and unvaporized oil from the reaction zone, flash distilling the unvaporized oil in a reduced pressure zone by pressure reduction, simultaneously passing charging oil for the process through a heating zone and heating the same therein to cracking temperature under pressure, thence discharging the heated charging oil directly into the reduced pressure zone, subjecting the vapors evolved in the reduced pressure zone and those removed from the reaction zone to common fractionation and separating from the commingled vapors a relatively heavy reflux and a lighter reflux, introducing the heavy reflux directly to the reaction zone, heating the lighter reflux to higher cracking temperature than the charging oil and thence discharging the same into the reaction zone, and finally condensing the fractionated vapors.

3. The process as defined in claim 1 further characterized in that said charging oil is of higher boiling point than said lighter reflux, the first-mentioned heating zone through which the charging oil is passed being maintained at lower temperature than said second heating zone in which the lighter reflux is heated.

MARION W. BARNES.