

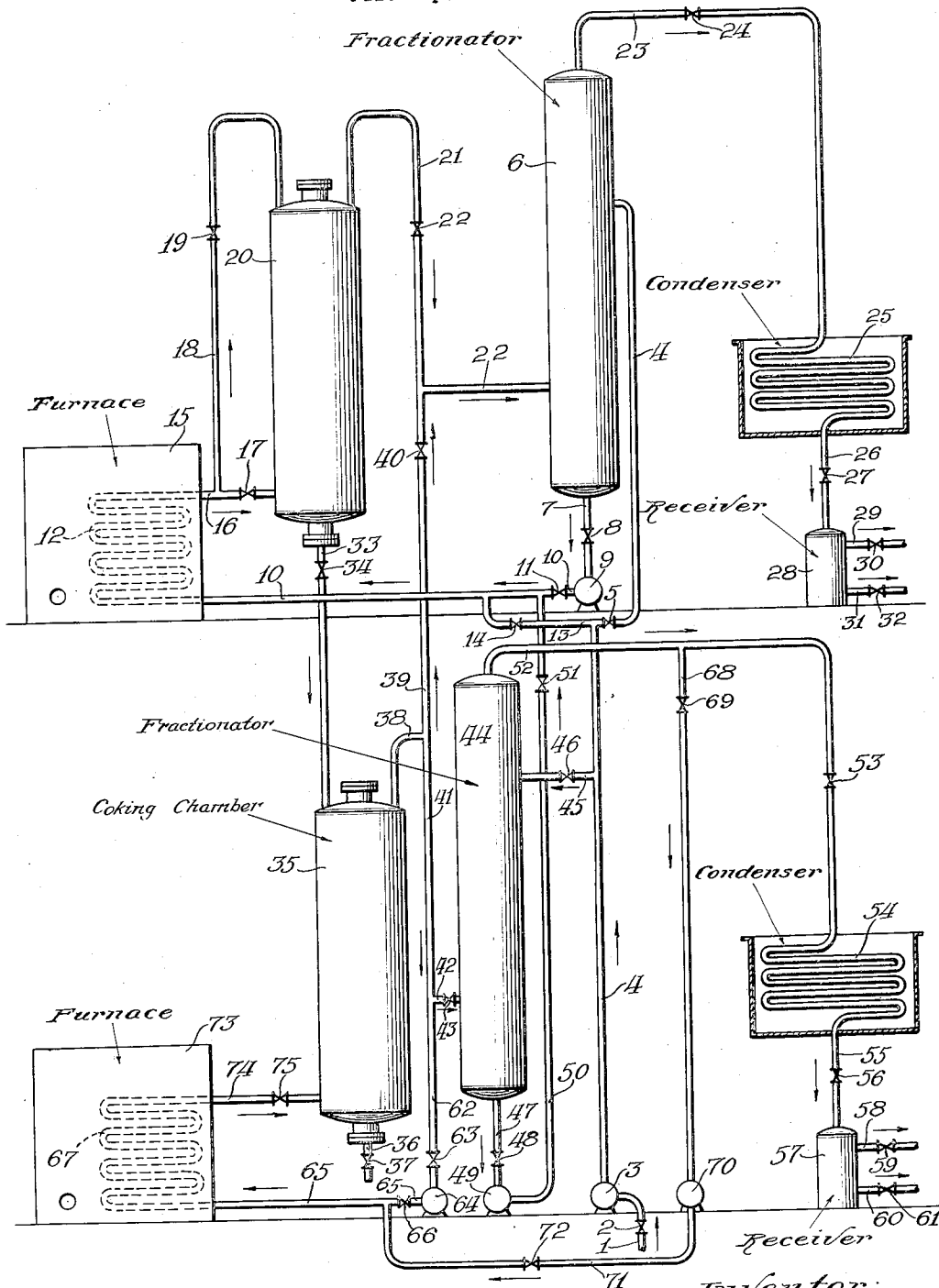
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J. C. MORRELL

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TREATMENT OF HYDROCARBON OIL

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Inventor:
Jacque C. Morrell.
By Frank L. Belknap
Attorney.

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TREATMENT OF HYDROCARBON OIL

Jacque C. Morrell, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill., a corporation of South Dakota

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3 Claims. (Cl. 196—60)

This invention relates to the conversion of hydrocarbon oils, and more particularly refers to an improved process and apparatus for the pyrolytic conversion of hydrocarbon oil accompanied by reduction of the residual conversion products to coke in a zone of reduced pressure relative to that at which they are formed.

The primary purpose of the present invention is to effect the substantial devolatilization and reduction of residual oil, produced by cracking at elevated temperature and superatmospheric pressure, to coke at substantially reduced pressure, and returning the intermediate products of the coking and cracking operations to further conversion in the same system. This method of operation permits the production of maximum yields of desirable light distillate such as motor fuel of high anti-knock value, the only other products of the operation being petroleum coke and hydrocarbon gases, and at the same time permits the formation of low volatile coke in a zone of reduced pressure which has certain economic advantages.

In the improved process of the present invention the production of a carbonaceous residue of minimum volatility is accomplished by reheating a portion of the vapors resulting from the coking operation to a high temperature and returning the highly heated vapors to direct contact with the residual material in the reduced pressure coking zone. The material thus reheated and utilized as a heat carrying medium to assist coking of the residual oil may comprise vapors resulting from the coking operation either prior or subsequent to their fractionation and the conditions under which they are subjected to reheating are such that their substantial conversion into additional yields of high anti-knock compounds is accomplished, thus insuring not only a carbonaceous product of minimum volatility but also high yield of light distillate of improved anti-knock value.

A specific embodiment of the invention may comprise subjecting hydrocarbon oil to conversion conditions in a heating coil, introducing the heated material into an enlarged reaction chamber maintained at superatmospheric pressure wherein vaporous and residual liquid conversion products separate, subjecting the vaporous products to fractionation, returning their heavy components condensed by said fractionation to the heating coil for further conversion, condensing and collecting the desirable light distillate product which remains uncondensed by fractionation, directing the non-vaporous residual liquid

products from the reaction chamber into a reduced pressure coking zone, subjecting vapors from the coking zone to fractionation, returning their heavy components condensed by fractionation to the heating coil for further conversion, condensing and collecting their desirable light components remaining uncondensed by fractionation, subjecting a portion of the vapors withdrawn from the coking zone to further heating in a separate heating coil and then introducing the highly heated vapors into direct contact with the residual material in the coking zone whereby its reduction to substantially devolatilized coke is effected.

Many modifications of the above specific embodiment are possible within the scope of the invention.

The attached diagrammatic drawing illustrates one specific form of apparatus embodying the principles of the present invention, and the following description of the drawing includes a description of several modifications of the operation described in the above specific embodiment.

Raw oil charging stock for the system supplied through line 1 and valve 2 to pump 3 may be fed through line 4 and valve 5 to fractionator 6, wherein it comes into direct contact with the vapors undergoing fractionation, is preheated thereby and assists their fractionation. The preheated raw oil collects in the lower portion of fractionator 6, together with reflux condensate produced by fractionation of the vapors in this zone, and is withdrawn therefrom through line 7 and valve 8 to pump 9, from which the combined feed (reflux condensate and raw oil) is fed through line 10 and valve 11 to heating coil 12. When desired, a portion or all of the raw oil, instead of being fed overhead to fractionator 6 may be supplied from line 4 through line 13 and valve 14 directly into line 10 and thence to heating coil 12 together with reflux condensate or combined feed, as the case may be, from fractionator 6.

Heating coil 12 is located in a furnace 15 of any desired form capable of supplying the required heat to the oil undergoing conversion. The heated oil is discharged from the heating coil through line 16 into reaction chamber 20, entering either the lower portion of this zone through valve 17 in line 16, or entering its upper portion through line 18 and valve 19.

Reaction chamber 20 as well as heating coil 12 is preferably maintained at substantial superatmospheric pressure and regardless of the manner in which the heated oil is introduced into

this zone, it is separated therein into vaporous and non-vaporous conversion products. In case the heated oil from heating coil 12 is introduced into the lower portion of chamber 20 through line 16 and valve 17 quicker separation of the residual oil from the vaporous products is effected than when the heated oil is introduced into the upper portion of the chamber through line 18 and valve 19. Also, by introducing heated oil into the lower portion of the chamber continued conversion, particularly of the vaporous products, is accomplished for a predetermined time as they pass upward through the chamber while the residual liquid may be removed from the reaction zone without substantial further conversion. When substantial further conversion of the residual liquid is desirable, line 18 and valve 19 is preferably utilized and, when desired, a substantial body of residual liquid may be maintained in chamber 20.

Vaporous conversion products are withdrawn from the reaction chamber through line 21 and valve 22 to fractionation in fractionator 6 wherein their heavy insufficiently converted components are condensed to be returned, as already described, to heating coil 12 for further conversion. Vaporous products remaining uncondensed in fractionator 6, comprising distillate of the desired end-boiling point and uncondensable gas, are withdrawn from the upper portion of the fractionator through line 23 and valve 24. are subjected to condensation and cooling in condenser 25, the distillate and gas passing therefrom through line 26 and valve 27 to be collected in receiver 28. Uncondensable gas may be released from receiver 28 through line 29 and valve 30. Distillate may be withdrawn from the receiver through line 31 and valve 32. A portion of the distillate from receiver 28 may, when desired, be recirculated by well known means (not shown) to the upper portion of fractionator 6 to assist fractionation and to maintain the desired vapor outlet temperature.

Non-vaporous residual liquid separated from the vaporous conversion products in chamber 20 is withdrawn from this zone through line 33 and valve 34 to coking chamber 35 which is preferably maintained at substantially reduced pressure relative to that employed in chamber 20. It will be understood that although only one coking chamber is shown in the drawing, a plurality of such zones may be employed, when desired, and may be operated either alternately or simultaneously to provide additional space for the accumulation of coke and thus prolong the operating cycle. Coking chamber 35 may be provided with a drain-line 36, controlled by valve 37, which may also be utilized as a means of introducing steam, water or other suitable cooling medium for cooling the chamber prior to cleaning.

Vapors are withdrawn from coking chamber 35 through line 38 and may pass either through line 39, valve 40 and line 22 to fractionator 6 to be subjected therein to the same treatment as that afforded vapors from reaction chamber 20, or vapors from the coking chamber may pass through line 41, line 42 and valve 43 to separate fractionation in fractionator 44. In case fractionator 44 is utilized, any desired portion or all of the raw oil charging stock may be directed from line 4 through line 45 and valve 46 into fractionator 44, being preheated therein by direct contact with the vapors undergoing fractionation and collecting together with the reflux condensate

produced by fractionation of the vapors in the lower portion of the fractionator.

Reflux condensate alone or reflux condensate and preheated raw oil, as the case may be, is withdrawn from the lower portion of the fractionator 44 through line 47 and valve 48 to pump 49 from which it is returned through line 50, valve 51 and line 10 to heating coil 12 for further conversion. It will be evident that regardless of whether the vapors from the coking chamber are supplied to fractionator 6 or to fractionator 44, their insufficiently converted components condensed by fractionation will be returned to heating element 12 for further conversion.

Vapors remaining uncondensed in fractionator 44, in case this zone is used, are withdrawn through line 52 and may pass through valve 53 to condensation and cooling in condenser 54. The distillate and uncondensable gas from condenser 54 passes through line 55 and valve 56 to be collected in receiver 57. Uncondensable gas may be released from receiver 57 through line 58 and valve 59. Distillate may be withdrawn from the receiver through line 60 and valve 61. A portion of the distillate collecting in receiver 57 may, when desired, be recirculated into the upper portion of fractionator 44, by well known means (not shown) to assist fractionation in this zone and to maintain the desired vapor outlet temperature therefrom.

In order to supply heat to accomplish the desired coking and devolatilization of the residual material in chamber 35, a portion of the vapors from this zone is reheated to a relatively high temperature and returned to the coking chamber. The vapors thus treated may be a portion of the vapors resulting from coking prior to their fractionation, in which case the desired portion of this product may be directed from chamber 35 through line 38, line 41, line 62 and valve 63 to pump 64 and fed therefrom through line 65 and valve 66 to heating coil 67, or when desired, the vapors utilized as the heat carrying medium for the coking operation may be a product resulting from fractionation of the vapors from coking chamber 35, in which case the desired portion of this product may be directed from fractionator 44 through line 52, line 68 and valve 69 to pump 70, to be fed therefrom through line 71, valve 72 and line 65 to heating coil 67. These alternatives are not equivalent as when fractionated vapors are utilized they may be subjected to a higher temperature in heating coil 67 than is possible with unfractionated vapors, without the danger of excessive coke deposition in the heating coil. This is due, of course, to the removal of heavy coke-forming materials from the vapors by fractionation. However, due to the relatively high temperature of the vapors removed from the coking chamber, prior to their fractionation when this product is used, less heating is required in heating coil 67 and a saving of fuel may be effected.

Heating coil 67 is located in a furnace 73 of any desired form capable of heating the material supplied thereto to the desired temperature. Conditions are preferably so regulated in heating coil 67 that substantial conversion of the materials supplied thereto is effected, resulting in the production of high yields of motor fuel of increased anti-knock value. The heated vapors are discharged from heating coil 67 through line 74 and valve 75 into coking chamber 35, preferably entering the lower portion of this zone, or at least below the level of residual material therein, so

that the heated vapors come into direct contact with the residual material in the coking chamber and effect its reduction to substantially dry coke.

may yield approximately 72% of motor fuel having an octane number of approximately 75 and in addition the process will produce, per barrel of charging stock, about 55 pounds of low volatile coke and approximately 800 cubic feet of uncondensable gas. 80

I claim as my invention:

1. In processes of the character wherein hydrocarbon oil is subjected to cracking conditions of heat and superatmospheric pressure in a heating coil with communicating reaction chamber, the vapors from the reaction chamber being fractionated, reflux condensate from the fractionator being returned to the heating coil for further treatment, the vapors from the fractionator being recovered, the non-vaporized residue from the reaction chamber being introduced into a coking chamber of reduced pressure with respect to the reaction chamber wherein non-vaporized residue and vapors are separated, the vapors subjected to fractionation, reflux condensate from the fractionator being returned to the heating coil, the improvement which comprises heating overhead vapors from the latter fractionation to vapor phase conversion temperature in a separate heating coil and introducing said heated vapors into the coking chamber to devolatilize and coke the contents thereof. 85 90 95 100

2. In processes of the character wherein hydrocarbon oil is subjected to cracking conditions of heat and superatmospheric pressure in a heating coil with communicating reaction chamber, the vapors from the reaction chamber being fractionated, reflux condensate from the fractionator being returned to the heating coil for further treatment, the vapors from the fractionator being recovered, the non-vaporized residue from the reaction chamber being introduced into a coking chamber of reduced pressure with respect to the reaction chamber wherein non-vaporized residue and vapors are separated, the vapors subjected to fractionation, reflux condensate from the fractionator being returned to the heating coil, the improvement which comprises heating a portion of the vapors from the coking chamber to vapor phase conversion temperature in a separate heating coil and returning the same to the coking chamber to devolatilize and coke the contents of said coking chamber. 105 110 115 120

3. In processes of the character wherein hydrocarbon oil is subjected to cracking conditions of heat and superatmospheric pressure in a heating coil with communicating reaction chamber, the vapors from the reaction chamber being fractionated, reflux condensate from the fractionator being returned to the heating coil for further treatment, the vapors from the fractionator being recovered, the non-vaporized residue from the reaction chamber being introduced into a coking chamber of reduced pressure with respect to the reaction chamber wherein non-vaporized residue and vapors are separated, the vapors subjected to fractionation, reflux condensate from the fractionator being returned to the heating coil, the improvement which comprises combining a portion of the vapors from the coking chamber with a portion of the vapors from the latter fractionation and subjecting the thus combined vapors to separate heat treatment at vapor phase conversion temperature, introducing the heated vapors into the coking chamber to coke and devolatilize the non-vaporized products contained therein. 125 130 135 140 145

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5 The cracking coil wherein the raw oil charging stock and reflux condensates are treated preferably utilizes conversion temperatures which may range from 800 to 950° F. or thereabouts. Substantial superatmospheric pressure of the order of 100 to 500 pounds, or more, per square inch is preferably utilized in this heating coil and in the reaction chamber. This pressure may be substantially equalized or reduced in the succeeding fractionating, condensing and collecting equipment. A substantially reduced pressure ranging, for example, from 100 pounds per square inch down to substantially atmospheric pressure is preferably employed in the coking zone and may be substantially equalized in the succeeding fractionating, condensing and collecting equipment. 10 15 20 The heating coil wherein vapors from the coking operation are reheated preferably utilizes a conversion temperature which may range from 900 to 1100 F. or thereabouts with substantial superatmospheric pressure ranging from 100 to 800 pounds, or more, per square inch. 25

As a specific example of the operation of the process of the present invention, an 18° A. P. I. gravity Mid-Continent fuel oil is subjected together with reflux condensate from the system, to a temperature of approximately 900° F. at a pressure of approximately 300 pounds per square inch. Substantially this same pressure is employed in the reaction chamber. The coking zone is maintained at a reduced pressure of approximately 50 pounds per square inch. Vapors from the coking zone are separately fractionated. A portion of the fractionated vapors is heated in a separate heating coil to a temperature of approximately 1,000° F. at a pressure of approximately 100 pound per square inch and the heated vapors are returned to the lower portion of the coking zone. This operation may yield approximately 68% of motor fuel having an anti-knock value equivalent to an octane number of approximately 72. In addition, there may be produced, per barrel of raw oil charging stock, approximately 85 pounds of coke having a volatile content of about 6% and about 1,000 cubic feet of uncondensable gas. 30 35 40 45

As a specific example of a somewhat different operation, within the scope of the invention, which may be practiced in an apparatus such as above illustrated and described, the raw oil charging stock is a 34° A. P. I. gravity gas oil which is subjected together with reflux condensate from the system to a temperature of approximately 910° F. at a superatmospheric pressure of about 350 pounds per square inch. Substantially this same pressure is employed in the reaction chamber but is reduced in the coking zone to slightly above atmospheric pressure. A portion of the vapors from the coking zone are directed to the same fractionator to which vapors from the reaction chamber are supplied. The fractionating, condensing and collecting equipment is maintained at a pressure substantially equalized with that in the coking zone. A portion of the vapors from the coking chamber are diverted from the line leading to the fractionator and are subjected in a separate heating coil to a temperature of approximately 950° F. at a superatmospheric pressure of about 500 pounds per square inch and the heated vapors are then introduced into the lower portion of the coking zone. This operation 50 55 60 65 70