

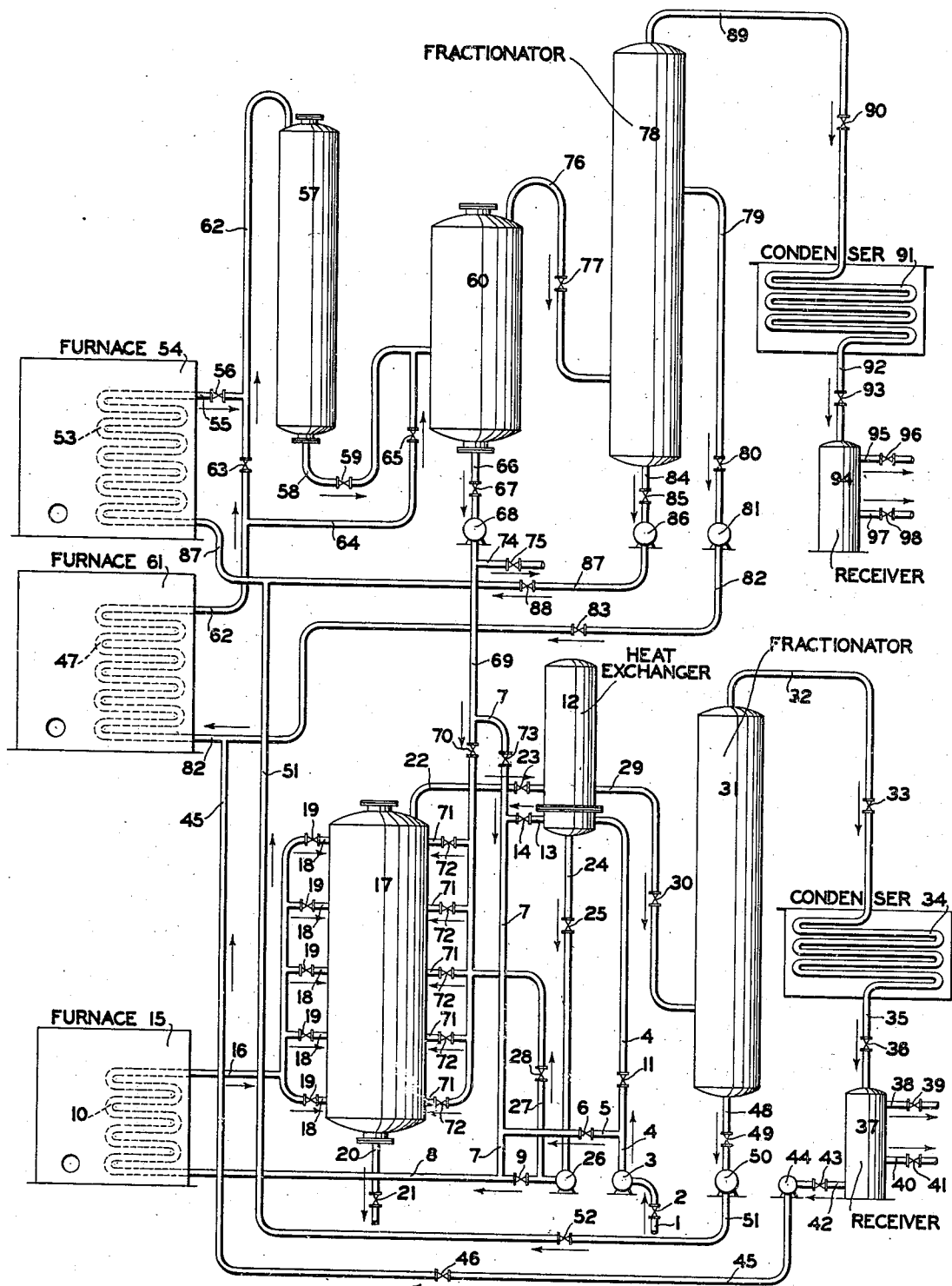
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CONVERSION AND COKING OF HYDROCARBONS

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CONVERSION AND COKING OF  
HYDROCARBONS

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This invention refers particularly to an improved process for the simultaneous conversion, coking and reforming of hydrocarbons, wherein the charging stock is subjected to coking at relatively low pressure, together with residual liquid resulting from the conversion of intermediate products of the process at substantial superatmospheric pressure, while selected low-boiling fractions of the vaporous products from the coking operation, including any motor fuel components, are subjected, either alone or together with selected low-boiling intermediate products of the conversion stage of the process, to independently controlled conversion conditions regulated to materially improve the characteristics of the motor fuel fractions, particularly with respect to anti-knock value, without excessively altering their boiling range and at the same time produce high yields of good quality motor fuel from any components of said low-boiling fractions boiling above the range of motor fuel.

The invention is particularly adapted to the treatment of charging stocks of a relatively high-boiling nature such as heavy crudes, topped crude, fuel oil and residual oils generally, or oils of relatively wide boiling range, such as crude petroleum, for example, including crudes containing an appreciable quantity of gasoline or gasoline fractions of poor anti-knock value. The invention also specifically contemplates the treatment of tars, pitches, asphaltic material and solid or semi-solid bituminous materials generally, including coal, peat, lignite, etc., preferably in finely divided state and in admixture with hydrocarbon oil.

The advantages obtained by the reduction of residual conversion products, resulting from the pyrolysis of hydrocarbon oils, to coke at relatively low pressure, as reflected in the increased yields of low-boiling liquid products, such as motor fuel, and the more uniform nature and low volatility of the coke produced, are well established. However, the low-boiling distillates within the range of motor fuel produced by such a coking operation, have been found in many cases, of inferior anti-knock value. I have further found, however, that these distillates, including, when desired, materials boiling somewhat above the range of motor fuel, may be converted under reforming conditions of elevated temperature and superatmospheric pressure to produce additional high yields of motor fuel of exceptionally good anti-knock value.

The present invention offers an advantageous method of accomplishing this in combination

with the subsection of relatively heavy oil, oil of relatively wide boiling range or carbonaceous materials generally to coking, together with the residual liquid conversion products of the process, and in case the charging stock thus subjected to coking contains materials within the boiling range of motor fuel, such as straight-run gasoline of low anti-knock value, for example, they may be recovered from the coking operation together with the other light distillates, including motor fuel produced therein, and subjected to reforming therewith, to produce high yields of motor fuel of materially improved anti-knock value, while the intermediate products of the cracking and coking operations, including any corresponding components of the charging stock which are not converted during the coking operation, are subjected in the same system to independently controlled conversion conditions best suited for their treatment.

Coking of the residual liquid conversion products of the process and heavy components of the charging stock may be accomplished in the present invention by subjecting either or both of these materials to heating, prior to their introduction into a low-pressure coking zone, under conditions of temperature, pressure and time regulated to effect the production of coke therefrom upon their introduction into the coking zone without detrimental coke formation in the heating zone. This particular feature of the invention possesses novelty in combination with the other features of the invention and is especially desirable in the present invention since it obviates the use of a heat carrying medium for the coking operation, such as low-boiling oil heated to a high conversion temperature. Motor fuel of good anti-knock value which would normally be produced from such low-boiling oils under the conditions of treatment to which they are best suited would be contaminated if introduced into the coking zone by the inferior motor fuel produced from the high-boiling oils subjected to coking. This would necessitate reforming treatment of the good quality motor fuel along with that of inferior quality since there is no economical method available for separating the two. However, it is not desired to limit the invention to this particular method of coking the heavy oils since any other well known method, including external heating of the coking zone as well as the introduction of suitable heat carrying media into the coking zone may be employed, when desired.

One specific embodiment of the present invention comprises subjecting charging stock for the

process to conversion temperature in a heating coil under conditions regulated to preclude any excessive coke formation in this zone, introducing the heated materials into a low-pressure coking chamber wherein low-boiling vaporous components of the charging stock separate from the higher boiling residue and the latter is reduced to coke, separating any entrained high coke-forming materials, such as tars, pitches and the like, from the vapors and returning the same to the coking zone, subjecting the vaporous products from the coking zone to fractionation, whereby their high-boiling components are condensed as reflux condensate, subjecting fractionated vapors of the desired end-boiling point, including motor fuels produced in the coking operation as well as any motor fuel components of the charging stock escaping conversion in the coking operation, to condensation, collecting and separating the resulting distillate and gas, subjecting the reflux condensate to conversion temperature at super-atmospheric pressure in a separate heating coil and communicating reaction chamber, separating the resulting vaporous and residual liquid conversion products, subjecting the residual liquid to coking, together with the charging stock, subjecting the vapors to fractionation in a separate fractionating zone, wherein their components boiling above the range of the desired final light distillate product of the process are condensed as reflux condensate, subjecting fractionated vapors of the desired end-boiling point to condensation, recovering the resulting distillate, separating the reflux condensate formed in said last mentioned fractionating zone into selected low-boiling and high-boiling fractions, returning the high-boiling fractions to the last mentioned heating coil for further conversion, subjecting the low-boiling fractions, together with said distillate recovered from the fractionator of the coking stage, to independently controlled conversion conditions of elevated temperature and super-atmospheric pressure in another separate heating coil and commingling the resulting heated products with the products resulting from said conversion of the high-boiling reflux condensate, prior to said fractionation of their vaporous components.

As a modification of the specific embodiment of the invention above described, the total reflux condensate from the fractionator of the cracking stage of the system may be subjected to conversion, together with the reflux condensate resulting from fractionation of the vaporous products from the coking zone, in which case only the distillate recovered from the coking stage of the system is subjected to conversion in the last mentioned heating coil.

A more detailed description of the process of the invention above outlined, as well as several of the many possible modifications thereof, will be found in connection with the following description of the accompanying diagrammatic drawing, which illustrates one specific form of apparatus in which the process may be carried out. It will be understood, of course, in connection with the following description of the drawing, that the invention is not limited to the specific form of apparatus illustrated and described and that the various alternative methods of operation mentioned are not to be considered equivalent but may be chosen to suit the particular nature of the materials undergoing treatment and the desired results.

Referring to the drawing, charging stock for

the process, which may comprise hydrocarbon oil or a mixture of liquid and suitable solid or semi-solid hydrocarbons, as previously mentioned, is supplied through line 1 and valve 2 to pump 3, by means of which it is fed through line 4 and may pass through line 5, valve 6 and lines 7 and 8 to heating coil 10. The charging stock may, of course, be preheated in any suitable well known manner, prior to its introduction into the heating coil. The drawing illustrates one specific method whereby this may be accomplished by passing a regulated portion or all of the charging stock through valve 11 in line 4 to heat exchanger 12, wherein it is preheated by indirect contact with hot vaporous products from the coking zone, the heated charging stock passing therefrom through line 13 and valve 14 into line 7 and thence through line 8 to heating coil 10.

Heating coil 10 is supplied with heat from furnace 15, of any suitable form, by means of which the oil passing through the heating coil is heated to the desired conversion temperature under suitable conditions of pressure (preferably super-atmospheric) and time (velocity) to preclude any excessive coke formation in the heating coil and connecting lines but at the same time heating the oil sufficiently to effect subsequent reduction of its residual components to coke. The heated materials are discharged from heating coil 10 through line 16 and may enter coking chamber 17 at any suitable point in this zone, as indicated in the drawing by lines 18 controlled by valves 19.

Coking chamber 17 is preferably maintained at substantially atmospheric or relatively low super-atmospheric pressure, of the order of 100 pounds or less, per square inch, and the coke formed in this zone is allowed to accumulate therein to be removed therefrom after the operation of the chamber is completed. When desired, a plurality of coking chambers similar to chamber 17, but not illustrated, may be employed to provide additional space for the deposition of coke and they may be simultaneously operated or, preferably, are alternately operated, cleaned and prepared for further operation so that the coking stage of the process may be continuous.

Chamber 17 is provided with a suitable drain-line 20 controlled by valve 21 which may also serve as a means of introducing water, steam or any other suitable cooling medium into the chamber after its operation is completed, to hasten cooling and facilitate cleaning of the chamber.

In the particular case here illustrated, vapors are removed from the coking zone through line 22 and pass through valve 23 into heat exchanger 12, wherein any high coke-forming components thereof, such as entrained particles of tar, pitch or the like, are removed by cooling, collecting as condensate in the lower portion of the heat exchanger, from which they may be withdrawn through line 24 and valve 25 to pump 26, by means of which they may be returned, all or in part, either through line 8 and valve 9 to heating coil 10 or through line 27 and valve 28 to coking chamber 17, entering this zone at any desired point as indicated by lines 71 controlled by valves 72.

Vaporous products from the coking zone remaining uncondensed in heat exchanger 12 may pass therefrom through line 29 and valve 30 to fractionation in fractionator 31, wherein their high-boiling components are condensed as reflux condensate, as will be later more fully described.

It is, of course, within the scope of the invention to by-pass heat exchanger 12, supplying the vaporous products from the coking zone direct to

fractionator 31, by well known means, not illustrated, or, when desired, to employ instead of or in conjunction with heat exchanger 12 any other suitable means of removing high coke-forming components and entrained liquids from the vapors.

Fractionated vapors of the desired end-boiling point, including conversion products within the boiling range of motor fuel, produced in the coking stage of the process as well as any motor fuel components of the charging stock, which latter will not ordinarily be subjected to any appreciable conversion in the coking stage, and also including, when desired, somewhat higher boiling materials such as naphtha, kerosene or kerosene distillate, pressure distillate bottoms and the like, are removed from the upper portion of fractionator 31 through line 32 and valve 33 and are subjected to condensation in condenser 34. The resulting distillate and gas passes through line 35 and valve 36 to collection and separation in receiver 37. Uncondensable gas may be released from the receiver through line 38 and valve 39. When desired, a regulated portion of the distillate may be withdrawn from receiver 37 through line 40 and valve 41 to storage or to any desired further treatment. Preferably, however, all or at least a portion of the distillate is withdrawn from receiver 37 through line 42 and valve 43 to pump 44, by means of which it is supplied through line 45, valve 46 and line 82 to further conversion in heating coil 47, as will be later more fully described.

Reflux condensate formed in fractionator 31, comprising the components of the vaporous products supplied to this zone boiling above the range of the desired light distillate product collected in receiver 37, is allowed to accumulate within the lower portion of fractionator 31 from which it is withdrawn through line 48 and valve 49 to pump 50 and supplied through line 51, valve 52 and line 87 to further conversion in heating coil 53.

Heating coil 53 is located within a furnace 54, of any suitable form, which supplies the required heat to the oil passing through the heating coil to bring it to the desired conversion temperature, preferably at a substantial superatmospheric pressure. The heated oil is discharged through line 55, valve 56 and line 62 to reaction chamber 57.

Chamber 57 is also preferably maintained at a substantial superatmospheric pressure, which may be substantially the same or somewhat lower than that employed at the outlet from the heating coil 53. Chamber 57 is also preferably well insulated, although not indicated in the drawing, in order to prevent excessive radiation and conserve heat so that conversion of the heated products supplied to this zone, and more particularly their vaporous components, may continue therein. In the particular case here illustrated both vaporous and liquid conversion products are withdrawn in commingled state from the lower portion of chamber 57 passing through line 58 and valve 59 to vaporizing chamber 60. It is, of course, also within the scope of the present invention to separately withdraw a regulated portion or substantially all of the vaporous conversion products from chamber 57 at any suitable point in this zone (not illustrated) in which case the vapors separately withdrawn may be supplied, all or in part, either to chamber 60 at any desired point or direct to fractionator 78 by well known means, not illustrated, while the liquid conversion products, either alone or together with a regulated portion of the vapors, may be supplied to chamber 60, as illus-

trated, or may be directed by well known means, not shown, to coking chamber 17 or to heating coil 10.

Heating coil 47 is located within a furnace 61 of any suitable form by means of which the oil passing through the heating coil is brought to the desired conversion temperature, preferably at a substantial superatmospheric pressure, although, when desired, relatively low pressures down to substantially atmospheric may be employed in this zone. Heated products are discharged from heating coil 47 through line 62 and may be directed, all or in part, either to reaction chamber 57 or to vaporizing chamber 60, entering either or both of these zones at any desired point therein. In the particular case here illustrated the heated products from heating coil 47 may pass through valve 63, in line 62, to commingle therein with the heated products from heating coil 53, passing therewith to chamber 57, or they may be diverted, all or in part, from line 62 through line 64 and valve 65 into line 58, commingling therein with the products passing from the lower portion of chamber 57 into vaporizing chamber 60.

Chamber 60, when such a zone is employed, is preferably operated at a substantially reduced pressure relative to that employed in the reaction chamber, by means of which further vaporization of the liquid conversion products supplied to this zone, as previously described, is accomplished. The residual liquid conversion products remaining unvaporized in chamber 60 may be withdrawn from the lower portion of this zone through line 66 and valve 67 to pump 68, by means of which they are fed through line 69 and may be directed, all or in part, through valve 70 in this line into coking chamber 17, entering this zone at any desired point or plurality of points, as indicated by lines 71 controlled by valves 72, or a regulated portion or all of the residual liquid may be diverted from line 69 through line 7 and valve 73 into line 8, passing therefrom into heating coil 10, together with the charging stock. It is, of course, also within the scope of the present invention to withdraw a regulated portion or all of the liquid residue produced in vaporizing chamber 60 from the system to cooling and storage or elsewhere, as desired. Line 74 controlled by valve 75 illustrates means whereby this may be accomplished. This permits the simultaneous production of both coke and liquid residue, when both are desired.

Vaporous products pass from the upper portion of chamber 60 through line 76 and valve 77 to fractionation in fractionator 78. The components of the vaporous products supplied to the fractionator boiling below the range of the desired final light distillate product of the process are condensed in this zone as reflux condensate, which may, when desired, be separated into selected low-boiling and high-boiling fractions. When the reflux condensate is so separated, its low-boiling fractions may be withdrawn from any suitable intermediate point or plurality of points in the fractionator, for example through line 79 and valve 80, to pump 81 by means of which they are returned through line 82 and valve 83 to further conversion in heating coil 47, together with the distillate from receiver 37. The high-boiling fractions of the reflux condensate or the total reflux condensate, in case it is not separated into selected low-boiling and high-boiling fractions, may be withdrawn from the lower portion of fractionator 78 through

line 84 and valve 85 to pump 86, by means of which it is returned through line 87 and valve 88 to further conversion in heating coil 53, together with the reflux condensate from fractionator 31.

Fractionated vapors of the desired end-boiling point, comprising the final light distillate product of the process, such as motor fuel of high anti-knock value, are withdrawn, together with uncondensable gas, from the upper portion of fractionator 78 through line 89 and valve 90, to be subjected to condensation and cooling in condenser 91. The resulting distillate and gas passes through line 92 and valve 93 to collection and separation in receiver 94. Uncondensable gas may be released from the receiver through line 95 and valve 96. Distillate may be withdrawn from receiver 94 through line 97 and valve 98 to storage or to any desired further treatment.

The usual expedients for controlling fractionation in fractionators 31 and 78 may, of course, be employed, although not illustrated. Such expedients may comprise, for example, returning regulated portions of the distillate products collected in receivers 37 and 94 to the upper portion of the respective fractionators 31 and 78, to serve as refluxing material to cool and assist fractionation of the vapors and maintain the desired vapor outlet temperatures from the fractionators.

It is also within the scope of the invention, when desired, to supply a separate charging stock to heating coil 47 or to heating coil 53 or both, although well known means for accomplishing this are not shown in the drawing. In such cases the charging stocks so employed are preferably within substantially the same boiling range as the materials from within the system with which they are subjected to conversion. For example, such oils as straight-run gasoline, naphtha, kerosene or kerosene distillate, pressure distillate, pressure distillate bottoms or the like may be suitable as secondary charging stock for heating coil 47 while a secondary charging stock for heating coil 53 may comprise, for example, such oils as crude petroleum, topped crude, gas oil, fuel oil and the like.

In a process of the character illustrated and above described, the preferred range of operating conditions may be approximately as follows: The heating coil to which the charging stock is supplied, either alone or together with residual liquid conversion products of the process, may utilize an outlet conversion temperature of the order of 825 to 950° F., preferably with a substantial superatmospheric pressure of from 100 to 500 pounds, or more, per square inch, and preferably, as already mentioned, the oil supplied to this zone is not maintained therein for a sufficient length of time to allow any excessive coke formation and deposition in this zone. A relatively low pressure of the order of substantially atmospheric to 100 pounds, or thereabouts, per square inch is preferred in the coking chamber and may be substantially equalized or somewhat reduced in the succeeding fractionating, condensing and collecting portions of the coking stage. The heating coil to which reflux condensate from the fractionator of the coking stage and the total or high-boiling fractions of the reflux condensate from the cracking system are supplied may utilize a conversion temperature, measured at the outlet therefrom of the order of 850 to 950° F., preferably with a substantially superatmospheric pres-

sure at this point in the system of from 100 to 500 pounds, or more, per square inch. Substantially the same or somewhat lower pressure may be employed in the reaction chamber and a substantially reduced pressure within the range of 100 pounds per square inch to substantially atmospheric pressure is preferred in the vaporizing chamber, when such a zone is employed. The pressures employed in the fractionating, condensing and collecting portions of the cracking stage may be substantially equalized or somewhat reduced relative to the pressure in the preceding portion of the system. The conversion temperature employed at the outlet from the heating coil to which distillate from the coking stage of the system, either alone or together with low-boiling fractions of the reflux condensate from the fractionator of the cracking stage is supplied, may range, for example, from 900 to 1050° F., and preferably a substantial superatmospheric pressure of from 200 to 800 pounds, or more, per square inch is employed at this point in the system, although, when desired, lower pressures down to substantially atmospheric may be employed in this zone.

As a specific example of one of the many possible operations of the process of the present invention, the charging stock may be a residual oil of about 15° A. P. I. gravity which is subjected, together with residual liquid from the vaporizing chamber of the cracking stage of the system, to a conversion temperature, measured at the outlet from the heating coil to which they are supplied, of approximately 940° F., at a superatmospheric pressure of about 300 pounds per square inch. The heated products are discharged into a coking chamber maintained at a superatmospheric pressure of about 30 pounds per square inch. Heavy tars and similar high coke-forming materials removed from the vaporous products from the coking chamber, prior to their fractionation, are returned to the coking chamber. The distillate recovered as the overhead product from the fractionator of the coking system has an end-boiling point of approximately 550° F. The higher boiling components of the vapors, which are condensed as reflux condensate, are subjected in a separate heating coil to an outlet conversion temperature of approximately 950° F., at a superatmospheric pressure of about 350 pounds per square inch and the heated products are introduced into a reaction chamber maintained at approximately the same pressure. The succeeding vaporizing chamber is maintained at a superatmospheric pressure of about 50 pounds per square inch and this pressure is substantially equalized in the succeeding fractionating, condensing and collecting portions of the cracking stage. High-boiling fractions of the reflux condensate from the cracking stage are returned to the same heating coil to which the reflux condensate from the fractionator of the coking stage is supplied. Low-boiling fractions of the reflux condensate from the fractionator of the cracking stage, having a boiling range of approximately 400 to 550° F., are subjected in another separate heating coil, together with the distillate recovered from the coking stage of the system, to an outlet conversion temperature of approximately 980° F., at a superatmospheric pressure of about 800 pounds per square inch and the heated products from this zone are introduced into the vaporizing chamber. This operation may produce, per barrel of charging stock, approximately 55% of 400 end-point motor fuel having an anti-knock value 75

equivalent to an octane number of approximately 72 and about 120 pounds of coke of relatively low volatility, the remainder being chargeable principally to uncondensable gas.

5 I claim as my invention:

1. A combined coking, cracking and reforming process which comprises distilling the charging oil to coke in a coking zone, fractionating resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing a substantial quantity of gasoline boiling hydrocarbons, heating the reflux condensate to cracking temperature under pressure while flowing in a restricted stream through a heating zone, passing the lighter fraction in a restricted stream through a second heating zone maintained at higher temperature than the first-named heating zone and heating the same therein sufficiently to enhance the anti-knock value of its gasoline content, commingling the thus heated lighter fraction with the heated reflux condensate discharged from the first-named heating zone, separating the commingled oils in a separating zone into vapors and residual oil, withdrawing such separated residual oil from the separating zone and introducing the same to said coking zone and reducing it to coke therein in admixture with the charging oil, separately removing the last-named vapors from the separating zone and fractionating and condensing the same.

2. A combined coking, cracking and reforming process which comprises distilling the charging oil to coke in a coking zone, fractionating resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing a substantial quantity of gasoline boiling hydrocarbons, heating the reflux condensate to cracking temperature under pressure while flowing in a restricted stream through a heating zone, passing the lighter fraction in a restricted stream through a second heating zone maintained at higher temperature than the first-named heating zone and heating the same therein sufficiently to enhance the anti-knock value of its gasoline content, commingling the thus heated lighter fraction with the heated reflux condensate discharged from the first-named heating zone, separating the commingled oils in a separating zone into vapors and residual oil, withdrawing such separated residual oil from the separating zone and introducing the same to said coking zone and reducing it to coke therein in admixture with the charging oil, separately removing the last-named vapors from the separating zone and fractionating the same to condense heavier fractions thereof, supplying such condensed fractions to the first-named heating zone for retreatment therein together with said reflux condensate, and finally condensing the fractionated vapors.

3. A combined coking, cracking and reforming process which comprises distilling the charging oil to coke in a coking zone, fractionating resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing a substantial quantity of gasoline boiling hydrocarbons, heating the reflux condensate to cracking temperature under pressure while flowing in a restricted stream through a heating zone, passing the lighter fraction in a restricted stream through a second heating zone maintained at higher temperature than the first-named heating zone and heating the same therein sufficiently to enhance the anti-knock value of its gasoline content, commingling the thus heated lighter

fraction with the heated reflux condensate discharged from the first-named heating zone, separating the commingled oils in a separating zone into vapors and residual oil, withdrawing such separated residual oil from the separating zone and introducing the same to said coking zone and reducing it to coke therein in admixture with the charging oil, separately removing the last-named vapors from the separating zone and fractionating the same to form a relatively heavy reflux condensate and a lighter reflux condensate, supplying the former to the first-named heating zone and the latter to said second heating zone for retreatment with the reflux condensate and the lighter fraction respectively of the coking operation, and finally condensing the fractionated vapors.

4. A process for treating crude oil containing natural gasoline which comprises distilling the crude to coke in a coking zone, fractionating the resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing the low anti-knock gasoline hydrocarbons evolved from the crude, heating the reflux condensate to cracking temperature under pressure in a heating zone and subsequently discharging the same into a separating zone, heating the lighter fraction in a second heating zone to higher temperature than the reflux condensate in the first-named heating zone and sufficiently to enhance the anti-knock value of its gasoline content, discharging the more highly heated lighter fraction into the separating zone and separating the commingled products in this zone into vapors and residual oil, discharging such separated residual oil from the separating zone into said coking zone and reducing the same to coke therein in admixture with the crude oil, separately removing the last-named vapors from the separating zone and fractionating and condensing the same.

5. A process for treating crude oil containing natural gasoline which comprises distilling the crude to coke in a coking zone, fractionating the resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing the low anti-knock gasoline hydrocarbons evolved from the crude, heating the reflux condensate to cracking temperature under pressure in a heating zone and subsequently discharging the same into a separating zone, heating the lighter fraction in a second heating zone to higher temperature than the reflux condensate in the first-named heating zone and sufficiently to enhance the anti-knock value of its gasoline content, discharging the more highly heated lighter fraction into the separating zone and separating the commingled products in this zone into vapors and residual oil, discharging such separated residual oil from the separating zone into said coking zone and reducing the same to coke therein in admixture with the crude oil, separately removing the last-named vapors from the separating zone and fractionating the same to condense heavier fractions thereof, supplying such condensed fractions to the first-named heating zone for retreatment therein together with said reflux condensate, and finally condensing the fractionated vapors.

6. A process for treating crude oil containing natural gasoline which comprises distilling the crude to coke in a coking zone, fractionating the resultant vapors to form a reflux condensate heavier than gasoline and a lighter fraction containing the low anti-knock gasoline hydrocar-

bons evolved from the crude, heating the reflux condensate to cracking temperature under pressure in a heating zone and subsequently discharging the same into a separating zone, heating the  
5 lighter fraction in a second heating zone to higher temperature than the reflux condensate in the first-named heating zone and sufficiently to enhance the anti-knock value of its gasoline content, discharging the more highly heated  
10 lighter fraction into the separating zone and separating the commingled products in this zone into vapors and residual oil, discharging such separated residual oil from the separating zone into

said coking zone and reducing the same to coke therein in admixture with the crude oil, separately removing the last-named vapors from the separating zone and fractionating the same  
5 to form a relatively heavy reflux condensate and a lighter reflux condensate, supplying the former to the first-named heating zone and the latter to said second heating zone for retreatment with the reflux condensate and the lighter fraction respectively of the coking operation, and finally  
10 condensing the fractionated vapors.

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