

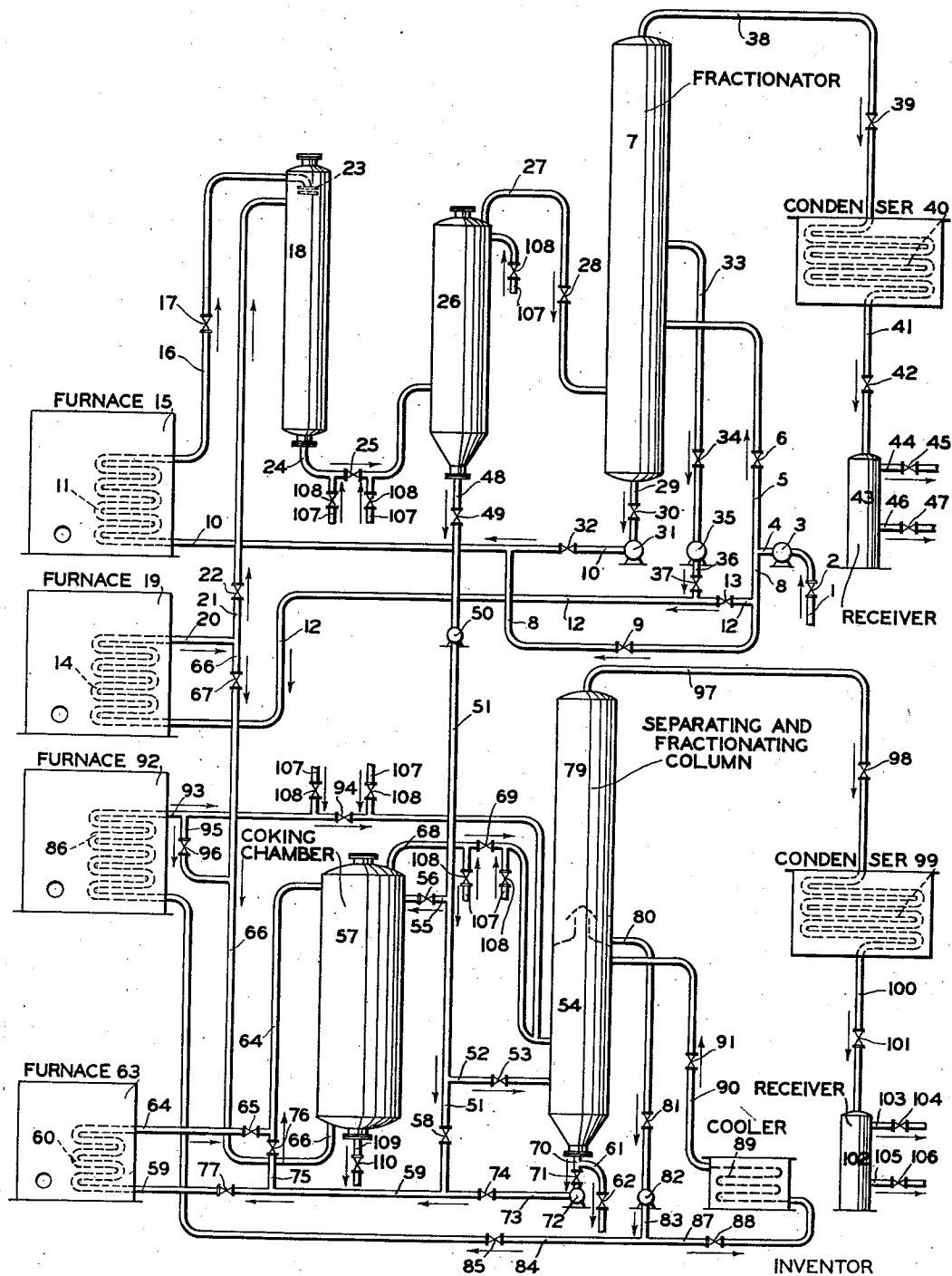
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L. C. HUFF

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CONVERSION OF HYDROCARBONS

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INVENTOR
LYMAN C. HUFF
BY *Lee Barry*
ATTORNEY

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CONVERSION OF HYDROCARBONS

Lyman C. Huff, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill., a corporation of Delaware

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This is a continuation-in-part of my co-pending application Serial No. 113,424, filed November 30, 1936.

The invention is directed to improvements in the type of cracking system wherein separate streams of hydrocarbon oils of different cracking characteristics are each simultaneously subjected to independently controlled cracking conditions. The process is operated for the production of high yields of good quality gasoline and minor yields of less valuable products including fixed gases and either liquid residue or coke. Either type of residual product may be produced to the substantial exclusion of the other or both may be produced simultaneously.

In operations of the type above mentioned, wherein it is desired to produce high yields of gasoline and minimize the production of residue, the advantage of reducing the high-boiling liquid conversion products to heavy high-boiling liquid residue or coke is now well recognized. Extensive further vaporization of the liquid conversion products boiling above the range of the normal recycled stock results in the recovery therefrom of substantial additional quantities of intermediate liquid products suitable for further cracking to produce additional yields of gasoline. For the sake of convenience, the intermediate liquid products recovered by said extensive further vaporization of the primary or normal residual liquid will be hereinafter termed "secondary recycle stock."

Heretofore it has been the practice to subject said secondary recycled stock to further cracking in commingled state with all or selected high-boiling fractions of the normal recycle stock (i. e. reflux condensate resulting from fractionation of the initial vaporous conversion products of the process).

I have found that this secondary recycle stock is advantageously cracked under cracking conditions controlled independently of those to which the normal recycle stock is subjected and have accordingly departed from conventional practice by providing for this method of operation in the present process. This is one of the important advantageous features of the invention.

Preferably, in the present invention, the secondary recycle stock is cracked at higher temperature than the normal recycle stock. However, in case the normal recycle stock is separated into selected relatively low-boiling and high-boiling fractions, which are separately cracked under independently controlled conditions, said low-boiling fractions may, when de-

sired, be cracked at substantially the same or somewhat higher or lower temperature than that employed for cracking of the secondary recycle stock. Preferably, however, the selected low-boiling fractions of the normal recycle stock are subjected to more prolonged conversion time at the desired high cracking temperature than that afforded the secondary recycle stock. To accomplish this separate heating coils are preferably employed for the secondary recycle stock and the light primary recycle stock, even though they are heated to substantially the same temperature, and preferably all or a substantial portion of the highly heated low-boiling fractions of the primary recycle stock are discharged from the heating coil into a reaction chamber wherein they are afforded additional cracking time at superatmospheric pressure, while the highly heated secondary recycle stock is supplied to a relatively low pressure zone of the system, such as the coking chamber or the zone wherein said appreciable further vaporization of the primary residual liquid is accomplished, whereby continued cracking of these products following their discharge from the heating coil is materially retarded or arrested. Cooling of these heated products upon their discharge from the heating coil to retard or arrest their further conversion may be accomplished by the reduction in pressure and/or by commingling a suitable cooling oil therewith, either or both methods being within the scope of the invention.

One specific embodiment of the invention, which, however, should be considered illustrative and is not intended to limit the invention to all of the steps recited, in combination, may comprise heating a hydrocarbon oil of relatively high-boiling characteristics to cracking temperature in a heating coil, simultaneously heating another hydrocarbon oil of lower boiling characteristics to a higher cracking temperature at superatmospheric pressure in a separate heating coil, supplying heated products from both heating coils to an enlarged reaction chamber wherein the commingled materials are subjected to appreciable further cracking at superatmospheric pressure, supplying the resultant vaporous and liquid conversion products from the reaction chamber to a primary vaporizing and separating chamber maintained at substantially reduced pressure relative to that employed in the reaction chamber, separately removing resultant vaporous and residual liquid conversion products from said primary vaporizing and separating chamber, fractionating the vapors in commingled

state with charging stock for the process which comprises a hydrocarbon oil of relatively wide boiling range, fractionally condensing the commingled materials in the fractionating step to

5 form a relatively heavy cracking stock and a relatively light cracking stock, supplying the former to the first mentioned heating coil and supplying the latter to the second mentioned heating coil, separately condensing fractionated vapors of

10 the desired end-boiling point to recover therefrom uncondensed normally gaseous products and a distillate which comprises a portion of the final gasoline product of the process, supplying liquid residue from said vaporizing and separating

15 chamber to a secondary vaporizing and separating chamber wherein it is appreciably further vaporized, removing resultant high-boiling liquid residue from the secondary vaporizing and separating chamber, quickly heating the same in a

20 separate heating coil to a sufficiently high temperature to induce subsequent coking thereof and introducing the resultant highly heated residual oil into a coking zone wherein said coking thereof is accomplished, directing the vaporous products of

25 the coking operation to said secondary vaporizing and separating chamber to commingle therein with the vapors evolved from said liquid residue in this zone, partially cooling the commingled vapors in said secondary vaporizing and separating

30 chamber to remove undesirable high-boiling components therefrom, commingling the latter with the high-boiling residual liquid supplied, as previously described, to the coking chamber, subjecting the remaining relatively clean components of the commingled vapors to fractionation

35 out of contact with the vaporous products supplied to the first mentioned fractionating step to form a separate cracking stock, cooling a regulated portion of the latter and returning the same

40 to the upper portion of said secondary vaporizing and separating chamber as a cooling medium for said commingled vapors, supplying the remainder of said separate cracking stock to another separate heating coil, therein heating the

45 same to an independently controlled high cracking temperature at superatmospheric pressure, discharging the resulting highly heated products from the last mentioned heating coil, partially cooling the same by substantially reducing the

50 pressure imposed thereon, separating high-boiling liquid components from the partially cooled products, returning said high-boiling liquid components to coking in the aforementioned coking step, fractionating the remaining uncondensed

55 vaporous components of said partially cooled products, returning the resultant condensate to the last mentioned heating coil for further cracking and condensing vaporous products resulting from said fractionation of the vaporous products

60 of the coking and last mentioned cracking step to recover therefrom uncondensed normally gaseous products and a distillate comprising another portion of said final motor fuel product of the process.

65 The specific embodiment of the invention above outlined, as well as various alternative methods of operation which are within the scope of the invention, are described in more detail in conjunction with the following description of the accompanying diagrammatic drawing. The drawing illustrates one specific form of apparatus in which various alternative methods of operation, each embodying certain features of the invention and the advantages which they afford, may be

70 conducted.

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Referring to the drawing, charging stock for the process which may comprise any desired type of hydrocarbon oil is supplied through line 1 and valve 2 to pump 3 by means of which it is fed through line 4 and, depending upon its characteristics and the desired type of operation, may be directed from line 4 either through line 5 and valve 6 into fractionator 7 or through line 8, valve 9 and line 10 to heating coil 11 or through line 8, line 12 and valve 13 to heating coil 14, or the charging stock may, when desired, be directed in part to fractionator 7 and in part to either of the heating coils 11 and 14.

The oil supplied to heating coil 11 is an oil of relatively high-boiling characteristics as compared with that supplied to heating coil 14 and it is heated in coil 11 to the desired cracking temperature, preferably at a substantial superatmospheric pressure, by means of heat supplied from furnace 15. The heated products are directed from heating coil 11 through line 16 and valve 17 into reaction chamber 18.

The relatively low-boiling oil supplied to heating coil 14 is heated at substantial superatmospheric pressure, preferably to a higher cracking temperature than that employed in heating coil 11, by means of heat supplied from furnace 19. The heated products are discharged from heating coil 14 through line 20 and are preferably directed therefrom, all or in part, through line 21 and valve 22 into reaction chamber 18 wherein they commingle with the heated products supplied to this zone from heating coil 11.

The hot conversion products supplied as described to chamber 18 are subjected to appreciable continued cracking in this zone, chamber 18 being maintained at a substantial superatmospheric pressure and preferably being insulated, although insulation is not indicated in the drawing, to conserve heat and effect additional cracking of the materials in this zone.

When desired, the heated products from heating coil 11 may be sprayed against the interior surface of the walls of chamber 18 by means of a suitable spray device or spreader flange, such as indicated, for example, at 23, or any other suitable means of quickly separating vaporous and heavy liquid components of the conversion products may be employed in chamber 18 for the purpose of affording the vaporous materials a longer conversion time in the reaction chamber than the liquids, whereby to prevent excessive continued cracking of the latter.

In the particular case here illustrated, both liquid and vaporous conversion products are withdrawn in commingled state from the lower portion of chamber 18 and directed therefrom through line 24 and valve 25 to vaporizing and separating chamber 26. The latter zone is preferably operated at a substantially reduced pressure relative to that employed in the reaction chamber and separation of resultant vaporous and residual liquid conversion products is accomplished in this zone. The components of the vapors supplied to and evolved in chamber 26 which remain uncondensed in this zone are directed from the upper portion thereof through line 27 and valve 28 to fractionation in fractionator 7. The liquid products which remain unvaporized in chamber 26 are separately removed from the lower portion of this zone and directed therefrom to further treatment, as will be later described.

The vaporous products supplied, as described, to fractionator 7 are subjected to fractionation

in this zone in commingled state with any hydrocarbon oil charging stock supplied thereto in the manner previously described and the components of the materials supplied to the fractionator which boil above the range of the desired overhead products of this zone may be condensed and separated by said fractionation into selected relatively low-boiling and high-boiling fractions. The latter are directed from the lower portion of fractionator 7 through line 29 and valve 30 to pump 31 by means of which they are supplied through line 10 and valve 32 to conversion, as previously described, in heating coil 11, while the former are withdrawn from one or a plurality of suitable points in the fractionator and supplied therefrom to conversion in heating coil 14, provision being made in the case here illustrated for directing the same from fractionator 7 through line 33 and valve 34 to pump 35 by means of which they are fed through line 36, valve 37 and line 12 to heating coil 14.

Fractionated vapors of the desired end-boiling point, comprising materials within the boiling range of gasoline and normally gaseous products, are directed, in the particular case here illustrated, from the upper portion of fractionator 7 through line 38 and valve 39 to condensation and cooling in condenser 40 wherefrom the resulting distillate and uncondensed gases pass through line 41 and valve 42 to collection and separation in receiver 43. The uncondensed gases may be released from the receiver through line 44 and valve 45 and distillate collected in receiver 43 is directed therefrom through line 46 and valve 47 to storage or to any desired further treatment.

When desired, regulated quantities of the distillate collected in receiver 43 may be recirculated by well known means, not illustrated, to the upper portion of fractionator 7 to serve as a cooling and refluxing medium in this zone.

Liquid products remaining unvaporized in chamber 26 and withdrawn, as previously mentioned, from the lower portion of this zone are directed therefrom through line 48 and valve 49 to pump 50 by means of which they are fed through line 51 and may be supplied therefrom either through line 52 and valve 53 to a secondary vaporizing and separating chamber 54 or from line 51 through line 55 and valve 56 directly into coking chamber 57 or they may be directed through valve 58 in line 51 through line 59 to heating coil 60, wherefrom the heated products are directed, as will be later described, into coking chamber 57. Pump 50 may be eliminated, when desired, in case the pressure employed in chamber 26 is appreciably higher than that employed in the zone to which the liquid residue from chamber 26 is supplied.

In case the liquid residue from chamber 26 is supplied as described to chamber 54, the latter zone is preferably operated at a substantially lower pressure and/or at an appreciably higher temperature than that employed in chamber 26, whereby appreciable further vaporization of said residual liquid is accomplished. Further vaporization of the liquid residue from chamber 26 and reduction of its high-boiling components to coke is accomplished in chamber 57 when this material is supplied, as previously mentioned, either directly to the coking chamber or through heating coil 60 into the coking chamber.

In case it is not desired to produce coke as a residual product of the process or in case it is desired to produce liquid residue in conjunction

with the production of coke, the non-vaporous heavy liquid products are preferably supplied, as previously described, from chamber 26 to chamber 54 and the resulting high-boiling liquid residue which remains unvaporized in this zone may be withdrawn, all or in part, from the lower portion of chamber 54 through line 61 and valve 62 to cooling and storage or elsewhere, as desired.

The use of heating coil 60 is optional in the present process, although an operation in which heating coil 60 is utilized is not to be considered equivalent to an operation in which it is not employed. Heating coil 60, when employed, functions as a zone wherein liquid residue supplied thereto from chamber 26, as previously described, and/or heavy residual liquid supplied thereto, as will be later described, from chamber 54 is quickly heated to a sufficiently high temperature to induce its further vaporization and subsequent reduction to coke, without allowing the highly heated oil to remain in the heating coil for a sufficient length of time to permit any excessive formation and deposition of coke in this zone and in the communicating lines. Furnace 63 supplies the required heat to the oil passing through heating coil 60 and, although coil 60 and furnace 63 are illustrated in a conventional manner in the drawing, they are preferably of the type, several forms of which are now well known in the art, employing relatively high oil velocities and high rates of heat transfer in order to obviate the long time for the oil in this zone. The highly heated products are discharged from heating coil 60 through line 64 and valve 65 into coking chamber 57 wherein their reduction to coke is accomplished either entirely by means of the heat imparted to the oil prior to its introduction into the coking zone or, when desired, with the assistance of a suitable heat carrying medium, as will be later described.

The coke produced in chamber 57 may be allowed to accumulate within this zone to be removed therefrom in any well known manner, not illustrated, after the chamber is substantially filled or after its operation has been completed for any other reason. A plurality of coking chambers is preferably employed, although only a single chamber is illustrated in the drawing, and preferably two or more chambers are alternately operated, cleaned and prepared for further operation so that the coking stage, in common with the rest of the system, may be operated continuously. Chamber 57 is provided with a drain line 109, controlled by valve 110, which may also serve, when desired, as a means of introducing water, steam or any other suitable cooling medium into the chamber, after its operation has been completed and preferably after it has been isolated from the rest of the system, in order to hasten cooling of the chamber and facilitate removal of the coke.

When desired, in order to assist the coking operation, regulated quantities of the highly heated products from heating coil 14 may be directed from line 20 through line 66 and valve 67 into chamber 57 and therein utilized as a heat carrying medium, the heated material preferably entering the lower portion of the coking chamber and coming into direct contact in this zone with the materials undergoing coking therein.

Vapors evolved from the residual liquids in chamber 57, as well as any vaporous products supplied to this zone, are directed from the upper portion thereof through line 68 and valve 69 into chamber 54 wherein they commingle with

the vaporous products evolved in the latter zone.

Ordinarily the vaporous products of the coking operation will contain entrained heavy liquid particles of a high coke forming nature and, in order to effect removal of these high-boiling liquids from the vapors and assist the desired separation of vaporous and residual liquid products in chamber 54, a suitable cooling medium is preferably supplied to the upper portion of this zone, as will be later described, and contacted therein with the vapors by any suitable means, not illustrated, such as, for example, baffles, perforated pans, bubble trays, sprays or the like. The heavy liquids thus removed from the vapors in chamber 54 commingle in the lower portion of this zone with the other residual liquid products which remain unvaporized therein and this heavy non-vaporous residual liquid is directed through line 70 and valve 71 to pump 72 by means of which it is supplied through line 73, valve 74 and line 59 to heating coil 60 and thence, after further treatment in this zone as previously described, through line 64 and valve 65 into coking chamber 57.

Heating coil 60 may be by-passed, when desired, by means of line 75 and valve 76, valves 77 and 65 in their respective lines 59 and 64 being closed.

The relatively clean vapors which remain uncondensed in chamber 54 are directed therefrom to fractionation in fractionator 79 and the components of these vapors boiling above the range of the desired overhead product from this zone are condensed therein as reflux condensate. The latter is withdrawn from the lower portion of fractionator 79 and directed through line 30 and valve 81 to pump 82 by means of which it is fed through line 83 and directed therefrom, all or in part, through line 84 and valve 85 to further treatment, as will be later described, in heating coil 86. The invention also contemplates the use of regulated quantities of the reflux condensate from fractionator 79 as a cooling medium in the upper portion of chamber 54 and, when this feature of the invention is utilized, a regulated portion of this material is directed from line 83 through line 87, valve 88, cooler 89, line 90 and valve 91 into the upper portion of chamber 54 wherein it functions in the manner previously explained. The invention is, of course, not limited to the use of this particular oil as a cooling medium in chamber 54, since other intermediate or final liquid products of the process or any suitable oil from an external source may be utilized when desired.

The reflux condensate supplied from fractionator 79 to heating coil 86 is heated therein preferably to a relatively high cracking temperature by means of heat supplied from a furnace 92 and a substantial superatmospheric pressure is preferably employed in heating coil 86. The heated products are discharged from heating coil 86 through line 93 and may be directed, all or in part, through valve 94 in this line into chamber 54. Preferably, the pressure employed at the outlet from heating coil 86 is substantially higher than that employed in chamber 54 and the reduction in pressure accomplished as the stream of heated products pass through valve 94 in line 93 serves to effect partial cooling of the heated products. Additional cooling thereof may be effected in chamber 54, as previously explained, and/or, as will be later described, in line 93 and preferably the cooling is sufficient to prevent any substantial further cracking of

the heated products. Separation of the vaporous and liquid components of the partially cooled products is accomplished in chamber 54, their vaporous components being subjected to fractionation in fractionator 79, while their non-vaporous residual liquid components are returned from chamber 54 either directly to coking chamber 57 or to heating coil 60 and thence to the coking chamber, in the manner previously described or they may be withdrawn from the system, all or in part, through line 61 and valve 62.

When desired, a regulated portion or all of the heated products from heating coil 86 may be directed from line 93 through line 95 and valve 96 and line 66 into the coking chamber wherein they may serve as a heat carrying medium and wherein their high-boiling non-vaporous components are reduced to coke.

Fractionated vapors of the desired end-boiling point, which comprises materials within the boiling range of gasoline and normally gaseous products, are directed from the upper portion of fractionator 79 through line 97 and valve 98 to condensation and cooling in condenser 99 wherefrom the resulting distillate and uncondensed gases are directed through line 100 and valve 101 to collection and separation in receiver 102. The uncondensed gases may be released from receiver 102 through line 103 and valve 104. Distillate collected in receiver 102 is directed therefrom through line 105 and valve 106 to storage or to any desired further treatment.

When desired, regulated quantities of the distillate collected in receiver 102 may be recirculated by well known means, not illustrated, to the upper portion of fractionator 79 to serve as a cooling and refluxing medium in this zone.

In addition to the previously described provisions for partial cooling of the conversion products the invention also contemplates controlled partial cooling of the relatively hot conversion products at various other points within the system, either for the purpose of retarding or arresting their continued cracking and/or for the purpose of assisting the desired separation of vaporous and liquid products. The various lines designated by the reference number 107 and controlled by the respective valves 108, are provided for this purpose. The invention is not limited to the particular material thus employed as a cooling medium, although it is preferably a suitable relatively light oil recovered from within the system, such as, for example, reflux condensate from fractionator 79, reflux condensate from fractionator 79, distillate from receiver 43 or receiver 102, or when desired, a combination of any of these materials. The cooling oil employed at these various points in the system may be selected to suit the requirements and may be cooled by well known means, not illustrated, prior to commingling with the relatively hot conversion products.

The preferred range of operating conditions which may be employed, within the scope of the invention, to accomplish the desired results in an apparatus such as illustrated and above described, may be approximately as follows: Heating coil 11 may employ an outlet conversion temperature ranging for example from 800 to 975° F., preferably, with a substantial superatmospheric pressure at this point in the system of from 100 to 500 pounds or more per square inch. Reaction chamber 18 may be maintained at any desired superatmospheric pressure not greater

than that employed in the communicating heating coil utilizing the lowest pressure, the preferred range being from 100 to 500 pounds per square inch. Vaporizing and separating chamber 26 is preferably operated at a substantially reduced pressure relative to that employed in chamber 18 ranging, for example, from a superatmospheric pressure of about 150 pounds or thereabouts per square inch down to approximately 25 pounds per square inch. Fractionator 7 and the succeeding fractionating, condensing and collecting portions of the system may employ pressures substantially the same or lower than that employed in chamber 26. Heating coil 14 preferably employs more severe cracking conditions than those utilized in heating coil 11, the temperature employed at the outlet of heating coil 14 ranging, for example, from 925 to 1025° F., preferably with a superatmospheric pressure at this point in the system of from 200 to 1000 pounds or thereabouts per square inch. Heating coil 86 preferably employs a temperature within the range of from 900 to 1050° F. and the superatmospheric pressure employed at the outlet of this zone may range for example from 100 to 1000 pounds per square inch. Preferably, as previously mentioned, heating coil 86 employs a higher temperature and shorter cracking time than that to which the light reflux condensate from fractionator 7 is subjected in heating coil 14 and reaction chamber 18. Heating coil 60 when utilized, may employ an outlet temperature ranging, for example, from 800 to 1000° F. or more, preferably with a superatmospheric pressure at this point in the system of from 30 to 300 pounds or thereabouts per square inch. The coking chamber may be operated at any desired pressure ranging from substantially atmospheric up to a superatmospheric pressure of 150 pounds or more per square inch and this pressure may be substantially equalized or reduced in separating chamber 54 and in the succeeding fractionating, condensing and collecting equipment.

As a specific example of one of the many possible operations of the process of the invention as it may be conducted in an apparatus such as illustrated and above described, the charging stock is a Mid-Continent topped crude having a gravity of approximately 24° A. P. I., an initial boiling point of approximately 495° F. and an end-boiling point of approximately 750° F. The charging stock is supplied to fractionator 7 wherein it is separated, together with reflux condensate formed in this zone, into selected relatively low-boiling and high-boiling fractions. The high-boiling fractions have a gravity of approximately 14° A. P. I. and contain approximately 42% of materials boiling up to 600° F. This material is supplied to heating coil 11 wherein it is heated to an outlet temperature of approximately 915° F. at a superatmospheric pressure of approximately 300 pounds per square inch. The low-boiling fractions of the charging stock and reflux condensate contain only a small amount of material boiling within the range of gasoline and have an end-boiling point of approximately 625° F. and a gravity of approximately 23° A. P. I. This material is supplied to heating coil 14 wherein it is heated to an outlet temperature of approximately 950° F. at a superatmospheric pressure of about 300 pounds per square inch. In this operation, the total heated products from heating coils 11 and 14 are supplied to reaction chamber 18 which is also main-

tained at a superatmospheric pressure of approximately 300 pounds per square inch. A superatmospheric pressure of approximately 125 pounds per square inch is employed in vaporizing and separating chamber 26 and this pressure is substantially equalized in the succeeding fractionating, condensing and collecting equipment of this stage of the system. Residual liquid from chamber 26 is supplied to secondary vaporizing and separating chamber 54 which is operated at a superatmospheric pressure of approximately 30 pounds per square inch. The resulting non-vaporous liquid residue is supplied from the lower portion of chamber 54 to heating coil 60 wherein it is quickly heated to an outlet temperature of approximately 950° F. at a superatmospheric pressure of about 115 pounds per square inch, the resulting heated products being introduced into the coking chamber wherefrom vaporous products are supplied to chamber 54. Fractionated vapors having an end-boiling point of approximately 400° F. are separately recovered from fractionators 7 and 19, condensed and the resulting gasoline recovered. The reflux condensate formed in fractionator 19 is in part cooled and returned to the upper portion of chamber 54 while the remainder is supplied to heating coil 86 and therein heated to an outlet temperature of approximately 960° F. at a superatmospheric pressure of approximately 130 pounds per square inch. The heated products discharged from heating coil 86 are cooled to a temperature of approximately 780° F. and thence introduced into chamber 54.

The above described operation will yield, per barrel of charging stock, approximately 85% of 400° F. end-point gasoline of good antiknock value and approximately 45 pounds of good quality coke. In addition, approximately 10% of residual liquid suitable for sale as heavy fuel oil is recovered from chamber 54. The only other product of the process is incondensable gas.

I claim as my invention:

1. A process for the pyrolytic conversion of hydrocarbon oils for the production therefrom of high yields of good antiknock gasoline and minor yields of less valuable products, which comprises heating an oil of relatively high-boiling characteristics to cracking temperature at superatmospheric pressure in a heating coil, simultaneously heating an oil of lower boiling characteristics to a higher cracking temperature at superatmospheric pressure in a separate heating coil, introducing heated products from both heating coils into an enlarged reaction chamber and subjecting the commingled materials therein to further cracking at superatmospheric pressure, supplying resultant vaporous and liquid conversion products from said reaction chamber to a reduced pressure vaporizing and separating chamber, removing resultant vapors and residual liquid separately from the latter zone, fractionating the vapors to form relatively heavy and relatively light reflux condensates and returning them, respectively, to the first mentioned and second mentioned heating coils for further cracking, condensing desirable low-boiling components of the fractionated vapors to recover a distillate comprising a portion of said gasoline product, supplying liquid residue removed from said vaporizing and separating chamber to a second vaporizing and separating chamber wherein it is further vaporized, removing resultant non-vaporous residue from said second vaporizing and separating chamber and reducing the same to

- coke in a coking zone, supplying vaporous products evolved in the coking zone to said second vaporizing and separating chamber to commingle therein with the vapors evolved in this zone from said liquid residue, fractionating the commingled vapors out of contact with the vaporous products supplied to the first mentioned fractionating step to form a separate reflux condensate, heating the latter to an independently controlled cracking temperature at superatmospheric pressure in another separate heating coil, introducing resultant conversion products from the last mentioned heating coil into said second vaporizing and separating chamber and therein separating their vaporous and liquid constituents, returning the latter to the coking step, commingling said vaporous constituents with the other vaporous products supplied to the last mentioned fractionating step and condensing fractionated vapors of the last mentioned fractionating step to recover therefrom desirable low-boiling components comprising another portion of said gasoline product.
2. A process such as defined in claim 1 wherein residual liquid removed from said second vaporizing and separating chamber is passed through another separate heating coil, quickly heated therein to a high cracking temperature sufficient to induce subsequent coking thereof and thence introduced into the coking zone.
3. A process such as defined in claim 1 wherein a regulated portion of the hot conversion products from the second mentioned heating coil are introduced into the coking zone to assist the coking therein of said residual liquid supplied thereto from the second vaporizing and separating chamber.
4. A process such as defined in claim 1 wherein at least a portion of the hot conversion products from the last mentioned heating coil are supplied directly to the coking zone.
5. A process such as defined in claim 1 wherein regulated quantities of said reflux condensate from the last mentioned fractionating step are cooled and returned to the upper portion of said vaporizing and separating chamber to assist the desired separation in this zone of vaporous and liquid components of the materials supplied thereto.
6. A process such as defined in claim 1 wherein charging stock for the process, comprising a hydrocarbon oil of relatively wide boiling range, is supplied to the first mentioned fractionating step and therein separated into relatively low-boiling and high-boiling fractions which are commingled, respectively, with said low-boiling and high-boiling reflux condensates and returned therewith to said further cracking.
7. A process for the pyrolytic conversion of hydrocarbon oils for the production therefrom of high yields of good antiknock gasoline, which comprises subjecting relatively low-boiling and higher boiling oils to independently controlled cracking conditions of elevated temperature and superatmospheric pressure in separate heating coils, subjecting heated products of the cracking operations to continued cracking in an enlarged reaction chamber also maintained at superatmospheric pressure, supplying the resulting vaporous and liquid conversion products from said reaction chamber to a zone of substantially reduced pressure wherein the liquid products are appreciably further vaporized and wherefrom resultant vapors and liquid residue are separately removed, fractionating the vapors for the formation of light and heavy reflux condensates and returning them, respectively, to the aforementioned light oil and heavy oil heating coils for further cracking treatment, condensing fractionated vapors of the desired end-boiling point and recovering resulting distillate as a portion of said gasoline products, supplying liquid residue removed from said zone of substantially reduced pressure to a coking chamber wherein it is appreciably further vaporized and its non-vaporous high-boiling components reduced to coke, contacting the vaporous products of the coking operation with a cooling oil and thereby removing undesirable high-boiling components such as entrained heavy liquids from the vapors, returning the thus removed high-boiling components of the coking chamber for further treatment, fractionating the remaining relatively clean vaporous products of the coking operation out of contact with the vapors undergoing fractionation in the first mentioned fractionating step to form another reflux condensate, cracking the latter in another separate heating coil under independently controlled cracking conditions of elevated temperature and superatmospheric pressure, commingling heated products of the last mentioned cracking operation with said vaporous products of the coking operation prior to their contact with said cooling oil, fractionating the resulting uncondensed vaporous products of the last mentioned cracking step in commingled state with said relatively clean vaporous products of the coking operation and recovering desirable low-boiling components from the commingled vapors of the last mentioned fractionating step as another portion of said gasoline product.
8. A process such as defined in claim 7 wherein liquid residue removed from said zone of substantially reduced pressure is passed through another separate heating coil, quickly heated therein to a high cracking temperature sufficient to induce subsequent coking thereof and the resulting highly heated oil introduced into the coking zone.
9. A process such as defined in claim 7 wherein a regulated portion of the hot conversion products from the second mentioned heating coil are introduced into the coking zone to assist the coking therein of said liquid residue supplied thereto.
10. A process such as defined in claim 7 wherein at least a portion of the hot conversion products from the last mentioned heating coil are supplied directly to the coking zone.
11. A process such as defined in claim 7 wherein regulated quantities of said reflux condensate formed in the last described fractionating step are cooled and contacted with the vaporous products of the coking and last mentioned cracking operation as said cooling oil.
12. A process such as defined in claim 7 wherein charging stock for the process, comprising a hydrocarbon oil of relatively wide boiling range, is supplied to the first mentioned fractionating step and therein separated into relatively low-boiling and high-boiling fractions which are commingled, respectively, with said low-boiling and high-boiling reflux condensates and returned therewith to said further cracking.
13. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a heating coil and subsequently separating the same into vapors and residual liquid in an enlarged chamber, fractionating the vapors and returning resultant re-

flux condensate to said coil, removing residual liquid from said chamber and further vaporizing the same in a second chamber, withdrawing remaining residual components from the second chamber and reducing the same to coke in a coking chamber, introducing vaporous products from the coking chamber to said second chamber to commingle with the vapors evolved in the second chamber, fractionating the commingled vapors from the second chamber independently of the vapors separated in the first-named chamber, subjecting reflux condensate formed by this fractionation to cracking conditions of temperature and pressure in a separate heating coil independently of reflux condensate formed in the first-mentioned fractionating step, discharging heated conversion products from said separate coil into said second chamber and therein separating the same into vaporous and residual components, and finally condensing the vapors uncondensed in said fractionating steps.

14. The improvement as defined in claim 13 further characterized in that a portion of the heated conversion products from said separate coil is introduced to the coking chamber to assist the coking operation therein.

15. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a heating coil and subsequently separating the same into vapors and residual liquid in an enlarged chamber, fractionating the vapors and returning resultant reflux condensate to said coil, removing residual liquid from said chamber and reducing the same to coke in a coking chamber, contacting the vaporous products of the coking operation with a cooling oil to separate high-boiling components of said products and returning the thus separated components to the coking operation, fractionating the remaining relatively clean vaporous products of the coking operation independently of the vapors separated in the first-named chamber, subjecting reflux condensate formed by this fractionation to cracking conditions of temperature and pressure in a separate heating coil independently of reflux condensate formed in

the first-mentioned fractionating step, commingling heated products from said separate coil with said vaporous products of the coking operation prior to the contacting of the latter with said cooling oil and fractionating the uncondensed portion thereof in admixture with said remaining relatively clean vaporous products of the coking operation, and finally condensing the vapors uncondensed in said fractionating steps, said process being further characterized in that a portion of the heated conversion products from said separate coil is introduced to the coking chamber to assist the coking operation therein.

16. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a heating coil and subsequently separating the same into vapors and residual liquid in an enlarged chamber, fractionating the vapors and returning resultant reflux condensate to said coil, removing residual liquid from said chamber and reducing the same to coke in a coking chamber, contacting the vaporous products of the coking operation with a cooling oil to separate high-boiling components of said products and returning the thus separated components to the coking operation, fractionating the remaining relatively clean vaporous products of the coking operation independently of the vapors separated in the first-named chamber, subjecting reflux condensate formed by this fractionation to cracking conditions of temperature and pressure in a separate heating coil independently of reflux condensate formed in the first-mentioned fractionating step, commingling heated products from said separate coil with said vaporous products of the coking operation prior to the contacting of the latter with said cooling oil and fractionating the uncondensed portion thereof in admixture with said remaining relatively clean vaporous products of the coking operation, utilizing a portion of the reflux condensate formed by the second-mentioned fractionating step as said cooling oil, and finally condensing the vapors uncondensed in said fractionating steps.

LYMAN C. HUFF.