

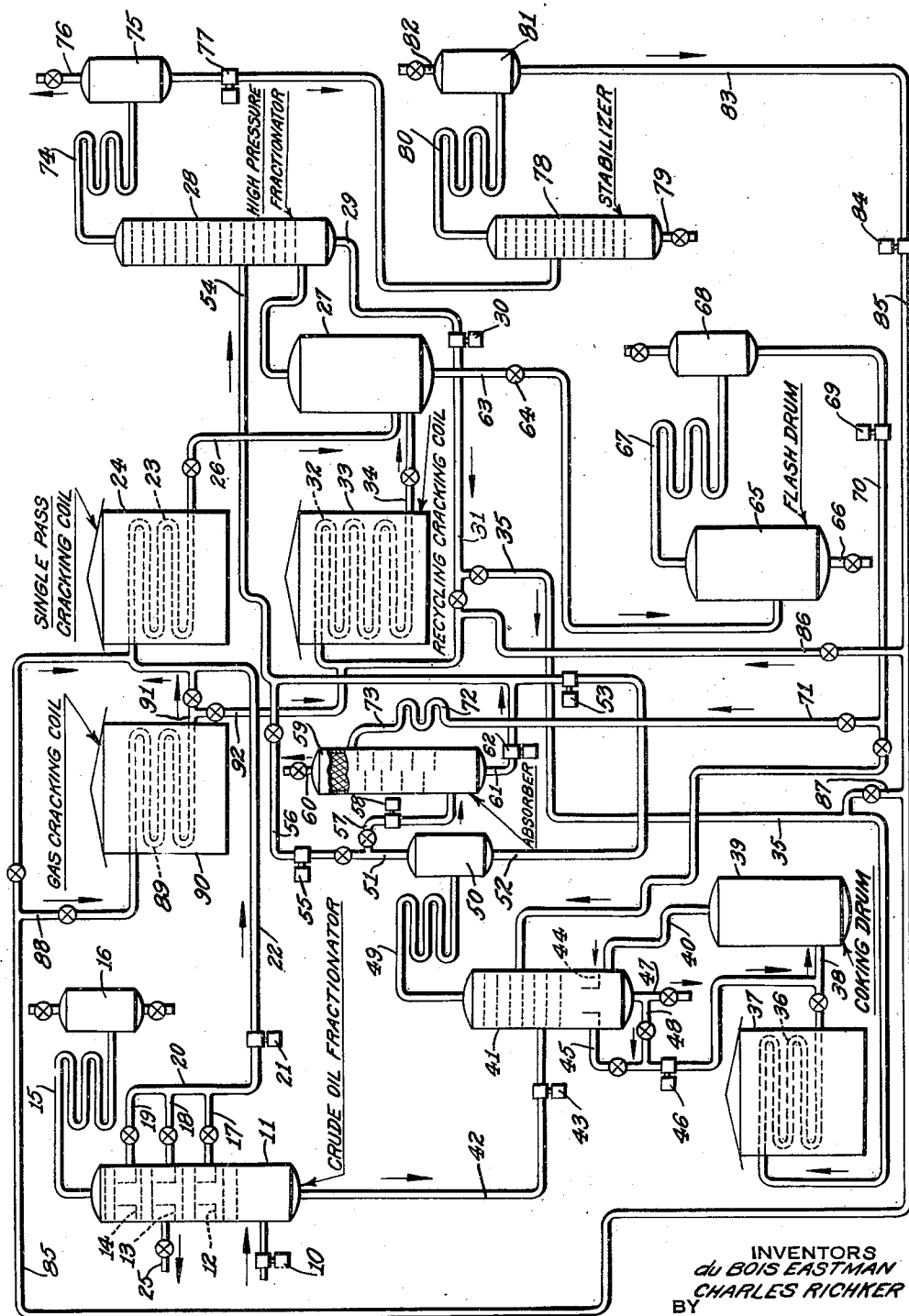
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CONVERSION OF HYDROCARBONS

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CONVERSION OF HYDROCARBONS

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This invention relates to the conversion of hydrocarbons for the production of gasoline or motor fuel and is concerned particularly with certain novel improvements in combination cracking and coking processes.

The invention contemplates a method of processing raw charging stock, such as crude petroleum, to ultimate yields of gasoline or motor fuel as well as for the production of a residual liquid fuel and coke. In accordance with the invention the coking operation is applied to the residual constituents of the crude petroleum and the cracked residual material derived from the cracking operation which constitutes the material on which the least advantage is obtainable through coking is reserved for the production of a liquid fuel product.

In the coking of topped or reduced crude relatively less gas is produced than in the coking of cracked residues and furthermore, the distillates obtained in the coking of the topped or reduced crude are less refractory and better adapted for cracking for conversion into gasoline than are the distillates produced in coking cracked residues. Furthermore, cracked residues possess a higher specific gravity for a given viscosity than topped or reduced crudes and a consequent higher calorific value. In accordance with the invention, therefore, the cracked residues are reserved for the production of liquid fuel while the topped or reduced crude is subjected to coking.

In practicing the invention the crude petroleum is fractionally distilled to obtain a residue and such additional fractions as may be desired, including a fraction suitable for cracking. The crude residuum is subjected to coking for immediate conversion into ultimate products. Fractions produced in the coking operation as well as straight run fractions are subjected to cracking and the cracked products fractionated to obtain a condensate. The major portion of this condensate is subjected to recycling cracking while a minor portion is separately heated and utilized to accomplish the coking of the crude residuum stock.

In a preferred embodiment of the invention, the topped or reduced crude is introduced into a fractionator in which the vapors from the coking operation are subjected to dephlegmation or fractionation and the resulting unvaporized residuum and heavy reflux condensate is directed into the coking zone, or combined directly with the hot products from the heating zone in which is heated that portion of the cycle condensate employed to aid in the coking operation. Distillate ob-

tained from the fractionator of the coking operation is introduced into the fractionator in which the vapors from the cracking operations are fractionated so that constituents from the coking operation are combined with other cracked fractions to form a reflux condensate, a portion of which is heated and directed to the coking zone while the other portion is subjected to a recycling cracking operation.

In accordance with the invention normally gaseous hydrocarbons, particularly C₃ and C₄ hydrocarbons, are recovered from the cracked products and subjected to polymerizing and reversion reactions together with hydrocarbon oil undergoing cracking in the complete process so as to thus increase the yield of liquid products particularly in the gasoline or motor fuel boiling range.

For the purpose of more fully disclosing the invention, reference is had to the accompanying drawing which is a flow diagram illustrating a particular embodiment of the invention.

In the apparatus shown in the drawing, crude oil, after being heated by heat exchange with hot products of the process, or otherwise heated to a desired distilling temperature, is introduced by a pump 10 to a distilling and fractionating tower 11. The tower is equipped with such fractionating elements and such cooling or refluxing means as may be necessary to accomplish the desired fractionation of the separated vapors and a plurality of trapout trays, as 12, 13 and 14 may be provided for the collection of such fractions as are desired. Uncondensed vapors pass to a condenser coil 15 and the distillate is collected in a receiving drum or gas separator 16. Typical fractions collected in the fractional distillation are: gas oil collected in tray 12, kerosene collected in tray 13, naphtha collected in tray 14, and a naphtha or gasoline distillate collected in receiver 16.

Lines 17, 18 and 19 extend respectively from trays 12, 13 and 14 to a manifold line 20 and pump 21 by which any or all of the fractions from trays 12, 13 and 14 may be conducted through a line 22 to a heating coil 23 positioned in a heating zone or furnace 24 adapted to heat the oil to a cracking temperature. It is frequently desirable to recover a kerosene or burning oil fraction from the crude to be marketed as such and a line 25 is indicated for the separate removal of this fraction. The cracked products from heating coil 23 pass through a transfer line 26 to a reaction chamber or separator 27 in which vapors separate from residue. The separated va-

pors pass to a fractionating tower 28 which is equipped with conventional fractionating elements and with such cooling and refluxing means as may be desired. Reflux condensate is drawn from tower 28 through a line 29 and is directed by a pump 30 through a line 31 to a heating coil 32 positioned in a heating zone or furnace 33 adapted to heat the oil to a cracking temperature. The cracked products pass from the coil 32 through a transfer line 34 to the separator or reaction chamber 27.

The line 31 has a branch line 35 which extends to a heating coil 36 positioned in a heating zone or furnace 37 which is adapted to heat the oil to a cracking temperature. A portion of the reflux condensate is directed through this line 35 to the heating coil 36 wherein it is heated to a cracking temperature and passed thence through a transfer line 38 to a coking drum 39. It is desirable to pass the major portion of the reflux condensate from tower 28 to the cracking coil 32 and utilize as small a proportion as possible to aid in the coking operation. The exact amount required for coking depends upon the temperature to which the cycle condensate can be heated in coil 36 without coking trouble therein or in the transfer line and the temperature desired to be maintained in the coking drum. It is recommended that about 20%-30% of the condensate be used in the coking operation, thus leaving 70%-80% for passage to the cracking coil 32. Vapors from the coking drum pass through a line 40 to a fractionating tower 41 which is provided with conventional fractionating elements and with such cooling or refluxing means as may be necessary to accomplish the fractionation desired.

Hot topped or reduced crude is drawn from the crude fractionator 11 through a line 42 and is directed by pump 43 into the tower 41 to dephlegmate the vapors therein and to receive the additional heat as well as to effect vaporization of constituents in the crude residue which it is not desired to subject to the coking operation. A trapout tray 44 is provided for collecting the resulting mixture of unvaporized crude residuum and reflux condensate. The mixture is withdrawn through a line 45 and directed by a pump 46 to the coke drum 39 or to the transfer line 38 so as to be thus commingled with the heated products from coil 36 for coking in the coke drum.

A line 47 extends from the bottom of the tower 41 for withdrawing the extremely heavy condensate which may precipitate therein below the trapout tray 44. In the coking operation a certain amount of heavy material of a highly polymerized character and of a more or less tarry nature may be carried off with the vapors and it is advantageous to fractionate out this material and withdraw it to constitute a portion of the liquid fuel oil product of the complete combination process. A cross-over line 48 may be provided so that in cases when it is not desired to segregate this primary or tarry condensate, it may be combined with the crude residual stock which is conducted by the pump 46 to the transfer line 38. In the latter operation either the tray 44 is omitted from the tower 41 or the combined residue and reflux condensate is permitted to overflow the tray and collect in the bottom of the tower and suction may be taken by pump 46 through lines 45, 48 and 47 so as to draw the mixture of residue and condensate from

the tower and combine it with the hot products from heating coil 36 for coking.

Uncondensed vapors from the tower 41 pass to a condenser coil 49 and the distillate is collected in the receiving drum or gas separator 50 having a gas line 51 and a distillate line 52. A pump 53 conducts the distillate from the accumulator 50 through a line 54 to the tower 28 so that the distillate may be refractionated in the tower and so that the constituents from the coking operation which are adapted for further cracking may be combined with, and constitute a part of, the reflux condensate which is separated out in the tower 28, while lighter constituents may pass overhead with the vapors from the tower.

The gases withdrawn from the accumulator 50 through line 51 may be placed under compression and the compressed constituents directed to the evaporator 27 or to the fractionator 28 so that normally gaseous hydrocarbons, adapted for polymerizing or reversion reactions, may be retained in the system and conserved for reaction as will presently be explained. A compressor 55 is shown which withdraws gases from accumulator 50 through line 51 and which may conveniently direct the compressed constituents through a line 56 thence to the line 54 leading to the tower 28. In some cases it is desirable to insert a cooler in the line 56 and release the lighter gases remaining uncondensed after compression by the pump 55 and pass to the tower 28 or separator 27 only the compressed liquid constituents. In an alternative method of handling the gas fraction from the accumulator 50, the gas line 51 is provided with a connection 57 leading to a compressor 58 by which the gases are directed to an absorber tower 59. The absorber tower is provided with a suitable absorbing menstruum, such as a portion of the reflux condensate from tower 28 which has been suitably cooled or oil from other sources as is hereinafter explained. Unabsorbed gases leave the tower 59 through a line 60 and the menstruum containing absorbed normally gaseous hydrocarbons is withdrawn through a line 61 by a pump 62 which may conveniently discharge the menstruum and absorbed gases into the line 54 for passage to the tower 28. Since the normally gaseous constituents which are handled by the compressor 55 constitute lighter constituents than the distillate which is withdrawn through line 52, it is often desirable to introduce the lighter fraction into a higher point in the tower 28 than that at which the condensate passing through line 52 is admitted but for convenience the compressor discharge line 56 has been shown as communicating with the common line 54. Similarly, the menstruum withdrawn from the tower 59 may also be introduced into a different point in the tower 28, instead of being combined with the distillate entering through line 54.

Residue from the reaction chamber or separator 27 is passed through a line 63 and pressure reduction valve 64 to a flash chamber 65 wherein the residue is flash-distilled under its contained heat and with the aid of steam or other stripping gas if desired. The flashed residue is withdrawn through a line 66 to constitute the liquid fuel oil product of the process. This product may be blended with the tarry product withdrawn from tower 41 through line 47. The flashed vapors pass from the chamber 65 to a condenser 67 and the distillate is collected in a receiving drum or gas separator 68. This distillate may be refluxed in the tower 28 or as shown it

may be directed by a pump 69 through a line 70 to the tower 41 for refractionation therein, together with the vapors from the coking operation. In this way the lighter components of the flashed constituents are combined with constituents from the coking operation as well as with any constituents from the crude residue which may have been vaporized in the tower 41 for passage to the tower 28 and finally for cracking in the recycling cracking coil 32, while heavier components may be combined with the constituents passing to the coking zone. The line 70 is provided with a branch line 71 so that a portion of the flashed distillate may be directed to a cooling coil 72 and passed thence through a line 73 to the absorber tower 59 to constitute the absorbing menstruum therein.

The uncondensed vapors from the tower 28 pass to a condenser 74 and the resulting distillate is collected in a receiving drum or gas separator 75 having a gas outlet 76. Distillate from the accumulator 75 may be directed by pump 77 to a rectifying tower 78 which is provided with conventional fractionating elements and with suitable heating or reboiling means as well as cooling or refluxing means to accomplish the desired stabilizing of the distillate. The rectified distillate product is withdrawn through line 79. The overhead fraction from the tower 78 which consists essentially of normally gaseous hydrocarbons passes to a cooling or condensing coil 80 thence to a distillate receiver 81. The tower 78, condenser 80 and accumulator 81 are maintained under suitable superatmospheric pressure to accomplish the desired rectification of the distillate. Lighter gaseous constituents, particularly methane and hydrogen, are removed through line 82 while higher boiling normally gaseous constituents, particularly C₃ and C₄ hydrocarbons, are collected as a liquid in the accumulator 81.

Normally gaseous constituents, particularly C₃ and C₄ hydrocarbons, are withdrawn from the accumulator 81 through a line 83 by a pump or compressor 84 having a discharge line 85 which communicates with the cracking coil 23 or with the line 22 leading thereto so that such normally gaseous constituents may be combined with the straight run distillate which is being subjected to cracking in the coil 23 to accomplish polymerizing and reversion reactions therein. The line 85 may be provided with a branch line 86 so that a portion of the normally gaseous fraction, or the entire fraction in lieu of directing such fraction to the cracking coil 23, may be introduced into the line 31 and combined with the cycle condensate being subjected to cracking in the heating coil 32 and thus subjected to polymerizing and reversion reactions therein. The line 85 may also be provided with another branch line 87 extending to the line 35 so that a portion or all of the normally gaseous fraction may be combined with the condensate which is subjected to cracking in the heating coil 36 to accomplish polymerizing and reversion reactions therein as well as in the coking drum 39.

It is sometimes desirable to subject the normally gaseous fraction to a separate thermal treatment prior to subjecting it to reversion reactions with normally liquid hydrocarbons and to accomplish this purpose line 85 may be provided with an additional branch line 88 which leads to a heating coil 89 positioned in a heating zone or furnace 90 adapted to supply the necessary heat to accomplish the desired pyrolysis of the hydrocarbons. A transfer line 91 leads to the

transfer line 22 so that the products of pyrolysis from the cracking and polymerizing may be combined with the straight run condensate and subjected to reaction therein in the heating coil 23. The line 91 is shown with a branch line 92 which communicates with the line 31 so that a portion or all of the products of pyrolysis from the coil 89 may be combined with the cycle condensate and subjected to reaction therewith in the cracking coil 32. The operation in the cracking coil 23 in single pass with respect to the liquid oil charge to the coil while the cracking coil 32 is recycling with respect to the liquid oil charge; both of these cracking coils are recycling with respect to the cycling of normally gaseous hydrocarbons.

In practicing the invention the fractional distillation of the crude oil may be conducted at approximately atmospheric pressure or at superatmospheric pressures such as 25 to 125 pounds with temperatures in the bottom of the fractionator 11 of from about 500° F. to 700° F., the exact temperature depending upon the extent of distillation desired. For example, when it is desired to separate out a gas oil cut in the tower 11 for subsequent cracking, a relatively high temperature such as 650° F. or 700° F. or even 750° F. may be employed. When it is desired to distill off only naphtha and kerosene in the tower 11, less heating of the crude oil is required for the distillation in the tower 11, and the gas oil fraction desired for cracking may be distilled off from the crude residue in the tower 41 by means of the hot vapors from the coking zone. The coking drum 39 and tower 41 are ordinarily held at superatmospheric pressures of about 25 to 125 pounds. The condensate in heating coil 36 is heated to temperatures of 900° F. to 1100° F. under pressures of 100 to 400 pounds and delivered to the coking drum 39 for maintaining the residual stock therein at the desired coking temperature. The vapors leave the coking drum at temperatures of about 800° F. to 900° F. The temperature in the bottom of tower 41 approximates 700° F. to 820° F., the temperature adjacent the tray 44, when used, being somewhat lower than the bottom temperature. The temperature at the top of 41 may be about 500° F.-700° F., preferably 600° F.-700° F. Temperatures of 950° F. to 1200° F. under 500 to 2000 pounds pressure are recommended for the gas cracking oil 89. Temperatures of 900° F. to 1100° F. under 200 to 1000 pounds pressure are recommended for the single-pass cracking coil 23 and temperatures of 900° F. to 1100° F. under 200 to 750 pounds pressure for the recycling cracking coil 32. High rates of cracking per pass such as rates of 20%-30%, as measured by conversion into 400° F. endpoint gasoline, are recommended for the single-pass cracking coil 23 while the rates of cracking per pass in the recycling cracking coil 32 will be generally lower, such as 15%-20%. The reaction chamber and separator 27 should be held under 200 to 400 pounds pressure with temperatures of 750° F. to 850° F. at the bottom of the chamber and temperatures of 700° F. to 800° F. in the top of the chamber. The fractionator 28 is preferably held under approximately the same pressure as that of the reaction chamber with temperatures of 700° F. to 800° F. in the bottom and temperatures of 400° F. to 550° F. at the top. The receiving drum 75 should be held under relatively high pressure such as 200 pounds or even higher, to insure that a minimum of C₃ and C₄ hydrocarbons will be released with the lighter

gases through the gas line 76 and so that there will be a maximum retention of the C₃ and C₄ hydrocarbons in the distillate which is passed to the stabilizer 78. The temperature-pressure conditions for stabilizing the gasoline distillate will vary with the particular stabilized product desired but generally speaking the stabilization should be conducted under pressures of 200 to 400 pounds with bottom temperatures of 350° F. to 400° F. and top temperatures of 100° F. to 200° F. In the flash drum 65 the pressure should be reduced to within a range of 25 to 100 pounds, with temperatures of 700° F. to 800° F. therein. The absorber 59 is preferably held under pressures as high as 200 pounds, pressures of 220 to 250 pounds being recommended, at normal temperatures or at temperatures of 100° F. to 120° F.

In a typical example of the invention, crude oil is fractionally distilled to recover a light gasoline product collected in receiver 16, a heavy naphtha fraction, collected in tray 14, having an initial boiling point of about 250° F. to 350° F. and an endpoint of about 500° F. and a kerosene fraction withdrawn from tray 13. The crude residue containing gas oil constituents is introduced into the tower 41 wherein the residue is further heated and vaporized so that gas oil constituents from the crude pass overhead from the tower and are collected as distillate in receiver 50. The unvaporized crude residuum combined with heavy reflux condensate is withdrawn from tray 44 at a temperature of 760° F. and combined with the hot products leaving cracking coil 36 at a temperature of 1050° F., with about 20% of the reflux condensate from tower 28 constituting the oil charged to the heating coil 36. Vapors leave the coking drum at a temperature of 900° F. Normally gaseous hydrocarbons from receiver 81 consisting predominantly of C₃ and C₄ hydrocarbons are combined with the straight run heavy naphtha and subjected to reforming and reversion reactions in the heating coil 23 at a temperature of 1050° F. under 800 pounds pressure. The remaining 80% of the reflux condensate from the tower 28 is subjected to cracking in the heating coil 32 at a temperature of 980° F. under 600 pounds pressure.

In another example of the invention, crude residue withdrawn from the tower 11 at a temperature of 700° F. is directed into tower 41 for further heating and vaporization. Unvaporized residue and heavy reflux condensate is withdrawn from tray 44 at a temperature of 780° F. and combined with the stream issuing from cracking coil 36 at a temperature of 1000° F. for coking in the coking drum from which the vapors leave at a temperature of about 900° F. A straight run kerosene fraction is withdrawn from tray 13 and a naphtha fraction, withdrawn from tray 14 and having a boiling range similar to that of the preceding example, is combined with the gas oil fraction withdrawn from tray 12 having an endpoint of about 700° F. The combined naphtha and gas oil fractions are combined with a normally gaseous fraction from receiver 81 consisting predominantly of C₃ and C₄ hydrocarbons and are subjected to a temperature in the coil 23 of 1050° F. under 800 pounds pressure to effect conversion of gas oil constituents into gasoline constituents as well as to effect reforming of gasoline constituents and polymerization and reversion of gaseous constituents to form normally liquid hydrocarbons of the gasoline boiling range. The reflux condensate from tower 28 is divided as in the previous example, a por-

tion passing to the heating coil 36 and the other portion being subjected to cracking in the coil 32 under conditions similar to that of the preceding example.

In each of the preceding examples the residue withdrawn from reaction chamber 27 is flash-distilled, the flash distillate is refluxed in the tower 41, and the distillate from receiving drum 50 is refluxed in the tower 28. The normally gaseous fraction from the receiver 50 is either placed under compression and resulting compressed constituents delivered to the tower 28, or such normally gaseous fraction is delivered to the absorber 59 into which a portion of the flashed distillate, which has been cooled, is introduced and the menstruum containing the absorbed hydrocarbons is delivered to the fractionator 28.

In any of the preceding examples the normally gaseous fraction withdrawn from the accumulator 81 by pump 84 may be directed to the recycling cracking coil 32, instead of to the cracking coil 23, for polymerizing and reversion reactions with the cycle condensate undergoing reaction.

In any of the preceding examples the normally gaseous fraction withdrawn from accumulator 81 by pump 84 may be passed through branch line 88 to heating coil 89 wherein the gas is subjected to cracking prior to combining it with normally liquid components undergoing cracking in either of the cracking coils 23 or 32. This procedure is advisable for the purpose of raising the olefin content of the normally gaseous fraction prior to combining it with the normally liquid constituents for polymerizing and reversion reactions.

Although a preferred embodiment of the invention has been described herein, it will be understood that various changes and modifications may be made therein, while securing to a greater or less extent some or all of the benefits of the invention, without departing from the spirit and scope thereof.

We claim:

1. The process of cracking hydrocarbons that comprises fractionating a crude petroleum stock in a first fractionating zone to separate residual constituents from lighter constituents, passing such residual constituents to a coking zone wherein the residual constituents are subjected to a coking temperature and reduced to coke, passing such lighter constituents to a cracking zone wherein they are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products in a separating zone distinct from the coking zone into vapors and residue, passing the separated vapors to a second fractionating zone wherein fractionation takes place to separate a reflux condensate from lighter fractions, directing a portion of said reflux condensate to a cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation in a separating zone distinct from the coking zone into vapors and residue and passing the separated vapors to the second fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and combining the resultant heated products with the aforesaid residual constituents to raise the temperature thereof and aid in reducing the same to coke, passing constituents vaporized in the coking operation to a cracking zone wherein such con-

stituents are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation in a separating zone distinct from the coking zone into vapors and residue and passing the separated vapors to the second fractionating zone.

2. The process of cracking hydrocarbons that comprises fractionating a crude petroleum stock to separate residual constituents from lighter constituents comprising normally liquid hydrocarbons, passing such residual constituents to a coking zone wherein the residual constituents are subjected to a coking temperature and reduced to coke, passing such lighter constituents comprising normally liquid hydrocarbons to a cracking zone wherein they are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products into vapors and residue, passing the separated vapors to a fractionating zone and subjecting the vapors therein to fractionation to form a reflux condensate, a lighter distillate product and heavier and lighter normally gaseous hydrocarbon fractions, combining said heavier normally gaseous hydrocarbon fraction with a portion of said reflux condensate and passing the mixture to a cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation into vapors and residue and passing the separated vapors to the aforesaid fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and combining the resultant heated products with the aforesaid residual constituents to raise the temperature thereof and aid in reducing the same to coke, passing constituents vaporized in the coking operation to a cracking zone wherein such constituents are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation and passing the separated vapors to the aforesaid fractionating zone.

3. The process of cracking hydrocarbons that comprises fractionating a crude petroleum stock to separate residual constituents from lighter constituents comprising normally liquid hydrocarbons, passing such residual constituents to a coking zone wherein the residual constituents are subjected to a coking temperature and reduced to coke, passing such lighter constituents comprising normally liquid hydrocarbons to a cracking zone wherein they are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products into vapors and residue, passing the separated vapors to a fractionating zone and subjecting the vapors therein to fractionation to form a reflux condensate, a lighter distillate product and heavier and lighter normally gaseous hydrocarbon fractions, introducing said heavier normally gaseous hydrocarbon fraction into the aforesaid cracking zone for reaction therein in contact with said normally liquid hydrocarbons, directing a portion of said reflux condensate from said fractionating zone to a cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation into vapors and residue and passing the sepa-

rated vapors to the aforesaid fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and combining the resultant heated products with the aforesaid residual constituents to raise the temperature thereof and aid in reducing the same to coke, passing constituents vaporized in the coking operation to a cracking zone wherein such constituents are heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the latter cracking operation and passing the separated vapors to the aforesaid fractionating zone.

4. The process of cracking hydrocarbons that comprises fractionating crude petroleum stock in a first fractionating zone to separate a residual fraction from a lighter fraction, introducing said residual fraction into a second fractionating zone to dephlegmate hot vapors therein and wherein fractionation takes place to form a heavy reflux condensate admixed with unvaporized constituents of said residual fraction and a lighter condensate, combining the resultant mixture of heavy reflux condensate and unvaporized residual constituents with a stream of hot products from a heating zone to thereby raise the temperature of said mixture and subjecting the combined products to coking in a coking zone to form a coke residue, passing resultant vapors from the coking operation to said second fractionating zone, directing said lighter fraction, obtained from the fractionation of the crude petroleum stock, to a single-pass cracking zone wherein it is heated to cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products in a separating zone distinct from said coking zone into vapors and residue, passing the separated vapors to a third fractionating zone and subjecting the vapors therein to fractionation to separate a reflux condensate from lighter fractions, directing a portion of said reflux condensate to a recycling cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the recycling cracking operation in a separating zone distinct from said coking zone into vapors and residue and passing the separated vapors to said third fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and utilizing the resultant heated products as said stream of hot products with which said mixture of heavy reflux condensate and unvaporized residual constituents is combined for coking as aforesaid, withdrawing said lighter condensate from the said second fractionating zone and introducing it into said third fractionating zone.

5. The process of cracking hydrocarbons that comprises fractionating crude petroleum stock in a first fractionating zone to separate a residual fraction from a lighter fraction, introducing said residual fraction into a second fractionating zone to dephlegmate hot vapors therein and wherein fractionation takes place to form a heavy reflux condensate admixed with unvaporized constituents of said residual fraction and a lighter condensate, combining the resultant mixture of heavy reflux condensate and unvaporized residual constituents with a stream of hot products from a heating zone to thereby raise the temperature of said mixture and subjecting the combined products to coking in a coking zone to form

a coke residue, dephlegmating the resultant vapors from the coking operation to form a heavy liquid fraction, withdrawing said liquid fraction and passing the uncondensed vapors to said second fractionating zone, directing said lighter fraction, obtained from the fractionation of the crude petroleum stock, to a single-pass cracking zone wherein it is heated to cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products in a separating zone distinct from said coking zone into vapors and residue, passing the separated vapors to a third fractionating zone and subjecting the vapors therein to fractionation to separate a reflux condensate from lighter fractions, directing a portion of said reflux condensate to a recycling cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the recycling cracking operation in a separating zone distinct from said coking zone into vapors and residue and passing the separated vapors to said third fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and utilizing the resultant heated products as said stream of hot products with which said mixture of heavy reflux condensate and unvaporized residual constituents is combined for coking as aforesaid, withdrawing said lighter condensate from said second fractionating zone and introducing it into said third fractionating zone.

6. The process of cracking hydrocarbons that comprises fractionating crude petroleum stock in a first fractionating zone to separate a residual fraction from a lighter fraction, introducing said residual fraction into a second fractionating zone to dephlegmate hot vapors therein and wherein fractionation takes place to separate a resultant mixture of heavy reflux condensate and unvaporized constituents of said residual fraction from lighter constituents, combining said mixture of heavy reflux condensate and unvaporized residual constituents with a stream of hot products from a heating zone to thereby raise the temperature of said mixture and subjecting the combined products to coking in a coking zone to form a coke residue, passing resultant vapors from the coking operation to said second fractionating zone, directing said lighter fraction, obtained from the fractionation of the crude petroleum stock, to a cracking zone wherein it is heated to cracking temperature under superatmospheric pressure and subjected to conversion, directing the resultant cracked products into a separating zone distinct from said coking zone and maintained under superatmospheric pressure and wherein separation of vapors from liquid residue takes place, passing the separated vapors to a third fractionating zone maintained under higher pressure than said second fractionating zone and subjecting the vapors therein to fractionation to separate a reflux condensate from lighter fractions, directing a portion of said reflux condensate to a recycling cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, passing the resultant cracked products into said separating zone, directing the liquid residue from said separating zone to a flashing zone distinct from said coking zone in which flashing zone the liquid residue is flash distilled under reduced pressure, combining resultant flashed constituents with lighter con-

stituents separated out in said second fractionating zone and introducing constituents so combined to said third fractionating zone.

7. The process of cracking hydrocarbons that comprises fractionating crude petroleum stock to separate a residual fraction from a lighter fraction, introducing said residual fraction into a fractionating zone to dephlegmate hot vapors therein and wherein fractionation takes place to separate a resultant mixture of heavy reflux condensate and unvaporized constituents of said residual fraction from lighter constituents, combining said mixture of heavy reflux condensate and unvaporized residual constituents with a stream of hot products from a heating zone to thereby raise the temperature of said mixture and subjecting the combined products to coking to form a coke residue, passing resultant vapors from the coking operation to said fractionating zone, directing said lighter fraction, obtained from the fractionation of the crude petroleum stock, to a cracking zone wherein it is heated to cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products into vapors and residue, passing the separated vapors to a fractionating zone maintained under higher pressure than the first-named fractionating zone to separate a reflux condensate from lighter fractions comprising normally liquid and normally gaseous hydrocarbons, further fractionating said lighter fractions to separate a normally liquid product and lighter and heavier normally gaseous constituents, combining heavier normally gaseous constituents thus separated with a portion of said reflux condensate and passing the mixture to a recycling cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure and subjected to conversion, separating the resultant cracked products of the recycling cracking operation into vapors and residue and passing the separated vapors to the said higher pressure fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and utilizing the resultant heated products as said stream of hot products with which said mixture of heavy reflux condensate and unvaporized residual constituents is combined for coking as aforesaid, and directing lighter constituents from the first-named fractionating zone to said higher pressure fractionating zone.

8. The process of cracking hydrocarbons that comprises fractionating crude petroleum stock to separate a residual fraction from a lighter fraction, comprising normally liquid hydrocarbons, introducing said residual fraction into a fractionating zone to dephlegmate hot vapors therein and wherein fractionation takes place to separate a resultant mixture of heavy reflux condensate and unvaporized constituents of said residual fraction from lighter constituents, combining said mixture of heavy reflux condensate and unvaporized residual constituents with a stream of hot products from a heating zone to thereby raise the temperature of said mixture and subjecting the combined products to coking to form a coke residue, passing resultant vapors from the coking operation to said fractionating zone, directing said lighter fraction, obtained from the fractionation of the crude petroleum stock, to a cracking zone wherein it is heated to cracking temperature under superatmospheric pressure and subjected to conversion, separating the re-

sultant cracked products into vapors and residue, passing the separated vapors to a fractionating zone maintained under higher pressure than the first-named fractionating zone to separate a reflux condensate from lighter fractions comprising normally liquid and normally gaseous hydrocarbons, further fractionating said lighter fractions to separate a normally liquid product and lighter and heavier normally gaseous constituents, introducing heavier normally gaseous constituents thus separated into the aforesaid cracking zone for reaction therein in contact with said normally liquid hydrocarbons, directing a portion of said reflux condensate to a recycling cracking zone wherein it is heated to a cracking temperature under superatmospheric pressure

and subjected to conversion, separating the resultant cracked products of the recycling cracking operation into vapors and residue and passing the separated vapors to the said higher pressure fractionating zone, directing another portion of said reflux condensate to a heating zone wherein it is heated to a cracking temperature and utilizing the resultant heated products as said stream of hot products with which said mixture of heavy reflux condensate and unvaporized residual constituents is combined for coking as aforesaid, and directing lighter constituents from the first-named fractionating zone to said higher pressure fractionating zone.

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