

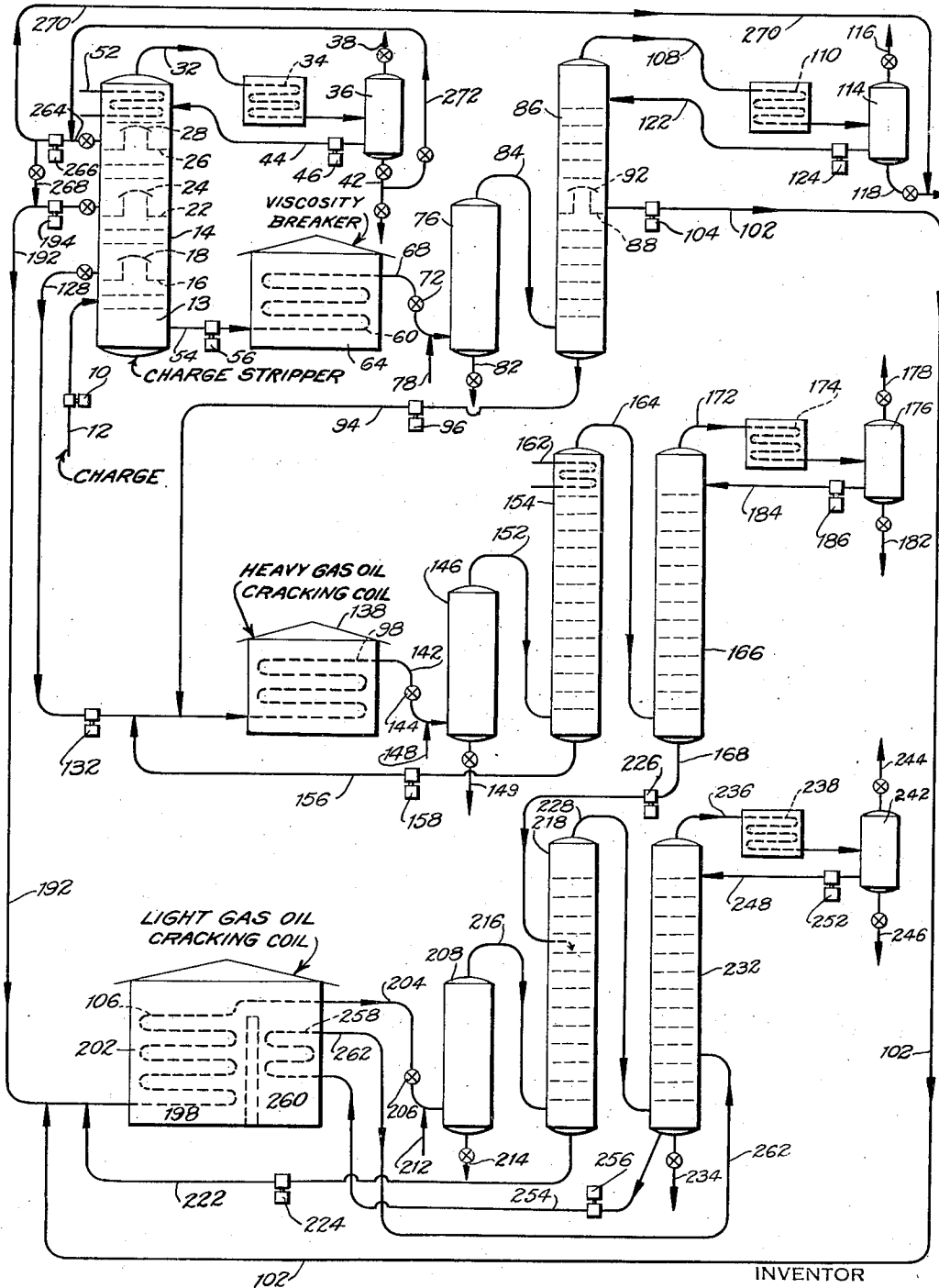
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CONVERSION OF HYDROCARBON OILS

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CONVERSION OF HYDROCARBON OILS

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2 Claims. (Cl. 196—49)

This invention relates to improvements in methods of converting higher boiling hydrocarbons into lower boiling hydrocarbons.

According to my invention a relatively heavy oil is subjected to mild cracking conditions to effect viscosity breaking thereof and the production of gas oil constituents to be used as stock to be cracked in other cracking operations in my process. The viscosity broken products are separated into vapors and cracked residue and the vapors are fractionated and separated into a heavy reflux condensate, a lighter reflux condensate and a light distillate product containing gasoline constituents.

The heavy reflux condensate is passed through a cracking zone where it is maintained under superatmospheric pressures and at high temperatures to effect the desired extent of cracking thereof. The cracked products are then passed to an evaporator or separating zone wherein vapors are separated from liquid residue. The vapors are fractionated to separate heavy reflux condensate containing insufficiently cracked products, which is recycled through the cracking zone, from a lighter reflux condensate and from a light distillate having the desired boiling range.

The lighter reflux condensate separated from the viscosity broken products is passed through a second cracking zone where it is maintained under superatmospheric pressures and at high temperatures to effect the desired extent of cracking thereof. The cracked products from the second cracking zone are separated into vapors and liquid residue and the vapors are fractionated to separate a light reflux condensate containing insufficiently cracked products, which is recycled through the second cracking zone for further cracking, from condensate oil such as furnace oil and from a light distillate product having the desired boiling range. The light reflux condensate separated during fractionation of the vapors derived from the first cracking zone is used as reflux in the fractionation of vapors separated from the cracked products coming from the second cracking zone.

To obtain the several fractions for use in the cracking zones in addition to those separated from the viscosity broken products, I may pass a heavy oil such as crude oil to a stripper or fractionating tower and withdraw the residue at the bottom of the tower for treatment in the viscosity breaking zone. Heavy gas oil, light gas oil, a heavy naphtha fraction and light overhead vapors are separated and may be withdrawn at different points from the tower and used as stocks to

be cracked in the cracking zones. The naphtha and light gas oil fractions may be combined and passed to the second cracking zone or the naphtha fraction may be separately treated in a reforming zone to enhance the anti-knock value thereof. Overhead vapors from the stripper or fractionating tower are condensed and may be separately collected, or mixed with the naphtha fraction withdrawn from the top portion of the stripper or fractionating tower.

The light distillate containing gasoline constituents separated from the vapors derived from the viscosity broken products may be collected as such, or it may be combined with the naphtha fraction withdrawn from the stripper or fractionating tower for further treatment in a reforming zone, or it may be combined with the light gas oil fraction from the stripper and fractionating tower for further treatment in the second cracking zone.

Further features and advantages of my invention will be apparent from the following detailed description taken in connection with the drawing which represents a diagrammatic showing of apparatus suitable for practicing the invention.

In the drawing, the reference character 10 designates a pump for passing a heavy oil charge, such as crude petroleum oil or topped crude, through a line 12. The heavy oil, preferably preheated in any suitable manner to a distilling temperature, is introduced into the bottom section 13 of a stripper or fractionating tower 14 wherein it is subjected to distillation. The tower 14 is provided with trap-out tray 16 having a hood 18, trap-out tray 22 having a hood 24 and trap-out tray 26 having a hood 28. The trap-out trays are vertically spaced within the stripper or fractionating tower 14 so that several fractions may be collected and withdrawn from the tower 14 during distillation and fractionation of the introduced oil.

The vapors remaining after fractionation leave the top of the tower 14 and are passed through line 32, through condenser 34, and the distillate containing gasoline constituents is collected in receiver 36 having a valved gas outlet 38 and a valved liquid outlet 42. A portion of the distillate may be returned to the top portion of the stripper or fractionating tower 14 through line 44 by pump 46 as reflux. If desired, a coil 52 may be used at the top of the tower 14 to provide additional cooling for the top thereof.

The crude residue collecting at the bottom of the stripper or fractionating tower 14 is withdrawn therefrom and passed through line 54 by

pump 56 and passed through the viscosity breaking zone or coil 60 extending through furnace 64. The products leaving the viscosity breaking zone or coil 60 are passed through line 68 preferably having a pressure reducing valve 72 into the evaporator or separating zone 76 wherein the products are separated into vapors and liquid residue. If desired, a quench oil may be introduced into the stream of products through line 78. The liquid residue is a fuel oil which is withdrawn through line 82 and further treated as desired. The separated vapors leave the evaporator or separating zone 76 through line 84 and are introduced into the bottom portion of the fractionating tower 86 provided intermediate its ends with a trap-out tray 88 having a hood 92.

The vapors are fractionated in the tower 86 to separate a heavy reflux condensate as, for example, a heavy gas oil which is withdrawn from the bottom of the fractionating tower 86 and passed through line 94 by pump 96 through the cracking zone or coil 98 as will be later described in more detail. During fractionation a light reflux condensate as, for example, a light gas oil is collected on trap-out tray 88 from which it is withdrawn and passed through line 102 by pump 104 into a second cracking zone or coil 106 as will be later described in more detail.

The vapors remaining after fractionation in the fractionating tower 86 are passed through line 108 and condenser 110, the distillate containing gasoline constituents being collected in a receiver or drum 114 having a valved gas outlet 116 and a valved liquid outlet 118. A portion of the distillate may be returned to the top of the fractionating tower 86 through line 122 by pump 124 as reflux. If desired, a coil may be used at the top of tower 86 to provide cooling therefor. The heavy reflux condensate which is withdrawn from the bottom of the fractionating tower 86 through line 94 may be admixed with the heavy reflux condensate which collects on the trap-out tray 16 in the stripper or fractionating tower 14 during fractionation of the heavy oil therein. The heavy reflux condensate from trap-out tray 16 is passed through line 128 by pump 132. The mixture of heavy reflux condensates is passed through the cracking zone or coil 98 in the furnace 138. The stream of products leaving the cracking zone or coil 98 passes through line 142 having a pressure reducing valve 144 and is introduced into the evaporator or separating zone 146 under a lower pressure. Before being introduced into the evaporator or separating zone 146 the stream of products may be quenched with an oil passing through line 148.

In the evaporator or separating zone 146 the products are separated into vapors and a liquid residue, the liquid residue being a fuel oil which is withdrawn through line 149. The separated vapors are passed through line 152 and introduced into the bottom portion of a primary fractionating zone 154 wherein heavy reflux condensate containing insufficiently cracked products is separated and collected on the bottom thereof. The heavy reflux condensate containing insufficiently cracked products is withdrawn from the bottom of the primary fractionating zone 154 and passed through line 156 and is recycled through the cracking zone or coil 98 by pump 158 to effect further cracking thereof.

Before passing through the cracking zone or coil 98 the heavy reflux condensate is preferably

mixed with the heavy reflux condensates to be cracked which are passed through lines 94 and 128 to the cracking zone or coil 98. The heavy reflux condensate passing through line 94 is withdrawn from the bottom of fractionating tower 86 where vapors from the viscosity breaking treatment are fractionated, and the heavy reflux condensate passing through line 128 is withdrawn from trap-out tray 16 in the stripper or fractionating tower 14 where the heavy feed oil is fractionated. The top of the primary fractionating zone 154 may be provided with a cooling coil 162 to provide cooling for the top of the primary fractionating zone 154.

The vapors remaining after fractionation in the primary fractionating zone 154 are passed through line 164 and introduced into the bottom portion of a secondary fractionating zone 166 wherein a separation into light vapors and a relatively light reflux condensate occurs. The relatively light reflux condensate is withdrawn from the bottom of the secondary fractionating zone 166 through line 168 and is directed to another fractionating zone later to be described. The light vapors remaining after fractionation in the secondary fractionating zone 166 pass through line 172 and condenser 174 and are collected as a distillate having the desired boiling range. The distillate is received or collected in a receiver or drum 176 having a valved gas outlet 178 and valved liquid outlet 182. Some of the distillate may be returned to the top of the secondary fractionating zone 166 through line 184 by pump 186 as reflux.

The light reflux condensate separated from vapors derived from the viscosity breaking treatment is withdrawn from trap-out tray 88 in the fractionating tower 86 through line 102 and is admixed with light reflux condensate such as a light gas oil which collects on trap-out tray 22 in the stripper or fractionating tower 14 and which is withdrawn therefrom and passed through line 192 by pump 194. The combined stream of light reflux condensates is passed through the cracking zone or coil 106 extending through the radiant section 198 of the furnace 202. The stream of cracked products leaves the furnace 202 through line 204 having a pressure reducing valve 206 and is introduced into the evaporator or separating zone 208 under lower pressure. Before being introduced into the evaporator or separating zone 208, the stream of cracked products may be quenched with an oil passing through line 212.

In the evaporator or separating zone 208 the cracked products are separated into vapors and a liquid residue, the liquid residue being withdrawn through line 214 as a fuel oil. The separated vapors leave the evaporator or separating zone 208 through line 216 and are introduced into the bottom portion of a primary fractionating zone 218 where a reflux condensate is separated from lighter vapors. The reflux condensate is withdrawn from the bottom of the primary fractionating zone 218 and is passed through line 222 by pump 224. This reflux condensate contains insufficiently cracked products and is recycled through the cracking zone or coil 106 after having been mixed with the light reflux condensates passing through lines 102 and 192 to be cracked in the cracking zone or coil 106.

The relatively light reflux condensate above referred to which is separated from vapors derived from the heavy gas oil cracking operation in zone or coil 98 is withdrawn from the bottom

of the secondary fractionating zone 166 and passed through line 168 by pump 226 and is introduced into the top portion of the primary fractionating zone 218 which functions to fractionate vapors derived from the light gas oil cracking operation in zone or coil 106. The light reflux condensate introduced into fractionating tower 218 through line 168 dephlegmates the vapors in the tower 218 to separate heavier constituents therefrom and some of the lighter constituents of the introduced reflux condensate are vaporized. The unvaporized constituents of the introduced reflux condensate together with the insufficiently cracked products from the bottom of primary fractionating zone 218 above referred to are directed to the cracking zone or coil 106 for further cracking. The vapors remaining after fractionation in the primary fractionating zone 218 together with vapors derived from the introduced light reflux condensate are passed through line 228 and introduced into the bottom portion of the secondary fractionating zone 232 wherein further fractionation takes place and light vapors are separated from a condensate oil. The condensate oil is a furnace oil which collects on the bottom of the secondary fractionating zone 232 and is withdrawn through line 234. If desired, a portion of the reflux condensate from the bottom of tower 232 may be refluxed on tower 218 at an intermediate point therein and recycled for further cracking, preferably being introduced below the point of introduction of the light reflux condensate introduced through line 168.

The separated vapors from the secondary fractionating zone 232 are passed through line 236 and condenser 238 and collected as a distillate having the desired boiling range. The distillate is collected in a receiver 242 having a valved gas outlet 244 and a valved liquid outlet 246. Some of the distillate may be returned to the top portion of the secondary fractionating zone 232 through line 248 by pump 252 as reflux. If desired, a coil may be used at the top of the secondary fractionating zone 232 to provide cooling therefor.

In order to remove substantially all of the light constituents from the bottoms of the secondary fractionating zone 232, the bottoms may be passed through line 254 by pump 256 and through the reboiler coil 258 extending through the convection section 260 of the furnace 202. The heated bottoms are then passed through line 262 and returned to the bottom portion of the secondary fractionating zone 232. By using the step of reboiling the bottoms from the secondary fractionating zone 232, undesirable light constituents are removed from the furnace oil which is withdrawn from the bottom of the secondary fractionating zone 232 through line 234. The furnace oil treated in this way has a boiling range to meet flash requirements. In some instances it may be desirable to also reboil the bottoms from the secondary fractionating zone 166.

During fractionation of the heavy oil in the stripper or fractionating tower 14 a heavy naphtha fraction containing gasoline is collected on trap-out tray 26 therein. This naphtha fraction is passed through line 264 by pump 266 and all or part thereof may be passed through line 268 and mixed with the light reflux condensate withdrawn from the trap-out tray 26 and the combined stream passed through line 192 to the cracking coil or zone 106. In this way the naphtha fraction is subjected to cracking and re-

forming while the light reflux condensate is being cracked. Instead of passing through line 268, the naphtha fraction may be passed through line 270 and mixed with the distillate withdrawn from the receiver 114. The mixture of the naphtha fraction and the distillate from receiver 114 derived from vapors separated from products obtained from the viscosity breaking treatment may be passed through a cracking and reforming coil or zone in order to reform the gasoline constituents and increase the anti-knock value of the motor fuel.

The light distillate collected in receiver 36 during the fractionation of the heavy oil in the stripper or fractionating tower 14 may be returned through line 272 to the line 264 and admixed with the naphtha fraction withdrawn from the trap-out tray 26 in the stripper or fractionating tower 14 for further treatment thereof as above described.

While I prefer to use a stripper and fractionating tower, in some instances the stripper and fractionating tower 14 may be omitted in which event a heavy oil such as reduced crude oil is treated in viscosity breaking zone or coil 60 and a heavy gas oil from an extraneous source is passed through cracking zone or coil 98, and a light gas oil from an extraneous source is passed through the second cracking zone or coil 106. The heavy gas oil is mixed with the heavy reflux condensate derived from the viscosity breaking treatment and with the recycle condensate oil from the bottom of primary fractionating zone 154; and the light gas oil is mixed with the light reflux condensate derived from the viscosity breaking treatment and with the recycle condensate oil from the bottom of primary fractionating zone 218 for treatment in the cracking zones as above described.

A typical operation according to my invention will now be given but it is to be understood that I am not restricted thereto. The charge of heavy oil which may be a crude petroleum, topped crude oil or other heavy oil is preferably preheated to a distilling temperature about 600 to 750° F. before it is introduced into the bottom portion of the stripper or fractionating tower 14 where it is subjected to distillation to remove all constituents boiling below 650 to 750° F. The tower 14 may be maintained under a pressure of atmospheric to about 100 pounds per square inch. The crude residue collecting at the bottom of the stripper or fractionating tower 14 has an initial boiling point of about 650 to 750° F. and is subjected to a viscosity breaking treatment by being passed through the viscosity breaking coil or zone 60 which is maintained under mild cracking conditions in order to effect the desired reduction in viscosity and the formation of gas oil constituents which can be further cracked under drastic cracking conditions to produce lower boiling constituents having high anti-knock value.

During its passage through the viscosity breaking coil or zone 60 the crude residue is maintained under a pressure of about 100 to 300 pounds per square inch, and at a temperature of about 750 to 925° F. The viscosity broken products leave the viscosity breaking zone or coil 60 under pressure of about 250 pounds per square inch and at a temperature of about 900° F.

The viscosity broken products are introduced into the evaporator or separating zone 76 which is maintained at a pressure of about 10 to 200 pounds per square inch, preferably about 15

pounds per square inch, and a separation into vapors and liquid residue occurs. The vapors are fractionated in the fractionating tower 86 to separate a heavy reflux condensate such as heavy gas oil from a lighter reflux condensate such as a light gas oil. The tower 86 is maintained under a pressure of about 10 to 200 pounds per square inch, preferably about 15 pounds per square inch. The heavy reflux condensate having an initial boiling point of about 650 to 750° F. is at a temperature of about 700° F. and is admixed with a heavy reflux condensate from the trap-out tray 16 in the stripper or fractionating tower 14 and with heavy reflux condensate withdrawn from the bottom of the primary fractionating zone 154.

The mixture of heavy reflux condensates having about the same initial boiling points is passed through the cracking zone or coil 98 wherein the oil is maintained under superatmospheric pressure and high temperature conditions in order to bring about the desired extent of cracking. During passage of the heavy reflux condensates through the cracking zone or coil 98 they are maintained at a temperature of about 825 to 1100° F. and under pressure of about 300 to 1000 pounds per square inch.

The cracked products leave the cracking zone or coil 98 at a temperature, for example, of about 925° F. and under a pressure of about 750 pounds per square inch and are passed to the evaporator or separating zone 146 which is maintained under a lower pressure of about 50 to 200 pounds per square inch, preferably about 110 pounds per square inch. The vapors leaving the evaporator or separating zone 146 are fractionated by being passed through the primary fractionating zone 154 and secondary fractionating zone 166 preferably maintained at the same pressure as the evaporator 146. The vapors remaining after fractionation are condensed and the distillate is a light motor fuel such as gasoline which may be further treated as desired. The condensate oil collecting on the bottom of the secondary fractionating zone 166 is directed to the primary fractionating zone 218 wherein vapors derived from products leaving the light condensate cracking zone or coil 106 are fractionated.

The light reflux condensate separated from the vapors derived from the viscosity breaking treatment is withdrawn from the fractionating tower 86 through line 102 and is admixed with light reflux condensate separated during the fractionation of the heavy oil in the stripper or fractionating tower 14. The light reflux condensates have an end point of about 650 to 750° F. The mixture of light reflux condensates together with the condensate oil withdrawn from the bottom of the primary fractionating zone 218 is passed through the second cracking zone or coil 106 wherein the oil is maintained at a temperature of about 825 to 1100° F. and under pressure of about 300 to 1000 pounds per square inch.

The cracked products leave the second cracking zone or coil 106 at a temperature, for example, of about 950° F. and under pressure of about 750 pounds per square inch. The cracked products are introduced into the evaporator or separating zone 208 maintained under about 50 to 200 pounds per square inch preferably about 110 pounds per square inch to separate vapors from a liquid residue and the vapors are fractionated by being passed through primary fractionating zone 218 and secondary fractionating zone 232.

The fractionating zones 218 and 232 are preferably maintained at the same pressure as the evaporator 208. The vapors leaving the top of the secondary fractionating zone 232 are condensed and the distillate is collected in the receiver 242. This distillate is a light motor fuel such as gasoline and may be further treated as desired.

The two gasoline products collected in receivers 176 and 242 may be separately treated or may be blended to produce any desired products.

In the preferred form of the invention the reboiler coil 258 maintains the bottoms of secondary fractionating zone 232 at a temperature of about 650° F. which is about 25 degrees higher than the bottoms of primary fractionating zone 218.

While I have described a particular embodiment of my invention, it is to be expressly understood that my invention is not restricted thereto, and various modifications and adaptations thereof may be made without departing from the spirit of my invention.

I claim:

1. A process for converting higher boiling hydrocarbon oils into lower boiling hydrocarbons which comprises passing a charging stock comprising residual constituents of crude petroleum once through a single-pass cracking zone wherein the oil is subjected to cracking conditions of temperature and pressure to effect viscosity-breaking thereof, passing resultant viscosity-broken products to a separating zone wherein vapors separate from liquid residue, passing resultant separated vapors to a fractionating zone wherein the vapors are fractionated to form a heavy gas oil condensate and a light gas oil condensate, directing the heavy gas oil condensate to a recycling cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing resultant cracked products from said recycling cracking zone to a second separating zone wherein vapors separate from residue, directing resultant separated vapors to a second fractionating zone wherein the vapors are fractionated to form a heavy reflux condensate and a lighter condensate, cycling said heavy reflux condensate to said recycling cracking zone, directing aforesaid light gas oil condensate to a second recycling cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing resultant cracked products from the second recycling cracking zone to a third separating zone wherein vapors separate from residue, passing resultant separated vapors to a third fractionating zone wherein the vapors are fractionated to form a heavy reflux condensate, an intermediate condensate and a light distillate, cycling the heavy reflux condensate from the third fractionating zone to the second recycling cracking zone, introducing said lighter condensate from the second fractionating zone to the third fractionating zone wherein it is subjected to vaporization and resultant vapors are subjected to fractional condensation to thereby combine constituents of said lighter condensate with the intermediate condensate in the third fractionating zone and withdrawing said intermediate condensate as a product of the process.

2. A process for converting higher boiling hydrocarbon oil into lower boiling hydrocarbons which comprises subjecting crude petroleum to fractional distillation to produce a crude residue,

5 a heavy gas oil condensate and a light gas oil
condensate, passing the crude residue once
through a single-pass cracking zone wherein the
residue is subjected to cracking conditions of
10 temperature and pressure to effect viscosity-
breaking thereof, passing resultant viscosity-
broken products to a separating zone wherein
vapors separate from liquid residue, passing re-
sultant separated vapors to a fractionating zone
15 wherein the vapors are fractionated to form a
heavy gas oil condensate and a light gas oil con-
densate, combining said heavy gas oil condensates
and directing the combined constituents to a
recycling cracking zone wherein they are sub-
20 jected to cracking conditions of temperature and
pressure to effect conversion into lower boiling
hydrocarbons, passing resultant cracked prod-
ucts from said recycling cracking zone to a sec-
ond separating zone wherein vapors separate
25 from residue, directing resultant separated va-
pors to a second fractionating zone wherein the
vapors are fractionated to form a heavy reflux
condensate, a lighter reflux condensate and a
final light distillate, cycling said heavy reflux
condensate to said recycling cracking zone, com-

binning aforesaid light gas oil condensates and
directing the combined constituents to a second
recycling cracking zone wherein they are sub-
5 jected to cracking conditions of temperature and
pressure to effect conversion into lower boiling
hydrocarbons, passing resultant cracked products
from the second recycling cracking zone to a
third separating zone wherein vapors separate
10 from residue, passing resultant separated vapors
to a third fractionating zone wherein the vapors
are fractionated to form a heavy reflux conden-
sate, an intermediate condensate and a light
distillate, cycling the heavy reflux condensate
15 from the third fractionating zone to the second
recycling cracking zone, introducing said lighter
reflux condensate from the second fractionating
zone to the third fractionating zone wherein it is
subjected to vaporization and resultant vapors
20 are subjected to fractional condensation to there-
by combine constituents of said lighter reflux
condensate with the intermediate condensate in
the third fractionating zone and withdrawing
said intermediate condensate as a product of the
process.

CHARLES W. NOFSINGER. 25