Oct. 31, 1944. K. M. WATSON 2,361,891

CONVERSION OF HYDROCARBON OILS

Filed Sept. 26, 1940 2 Sheets-Sheet 1

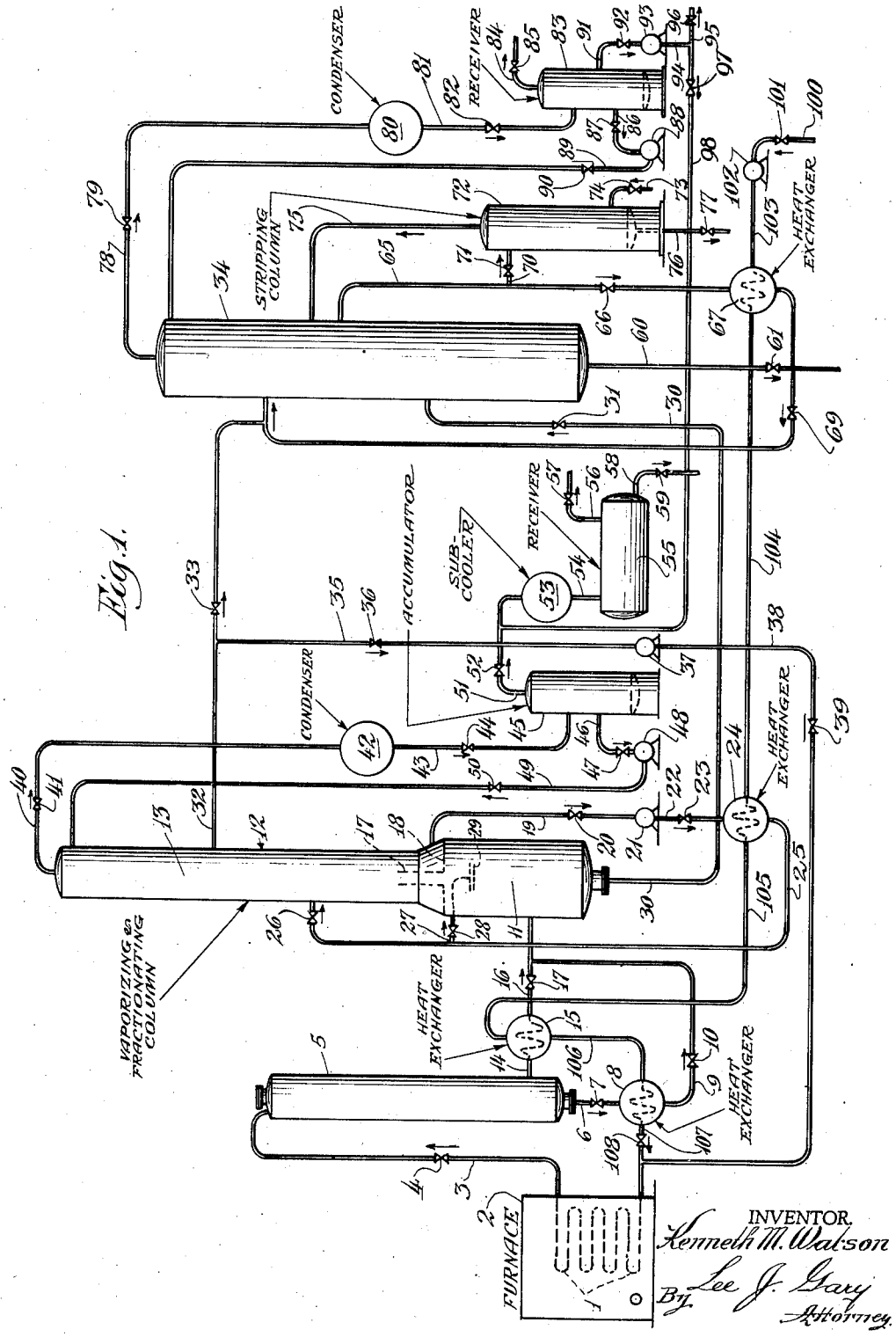


Fig. 1.

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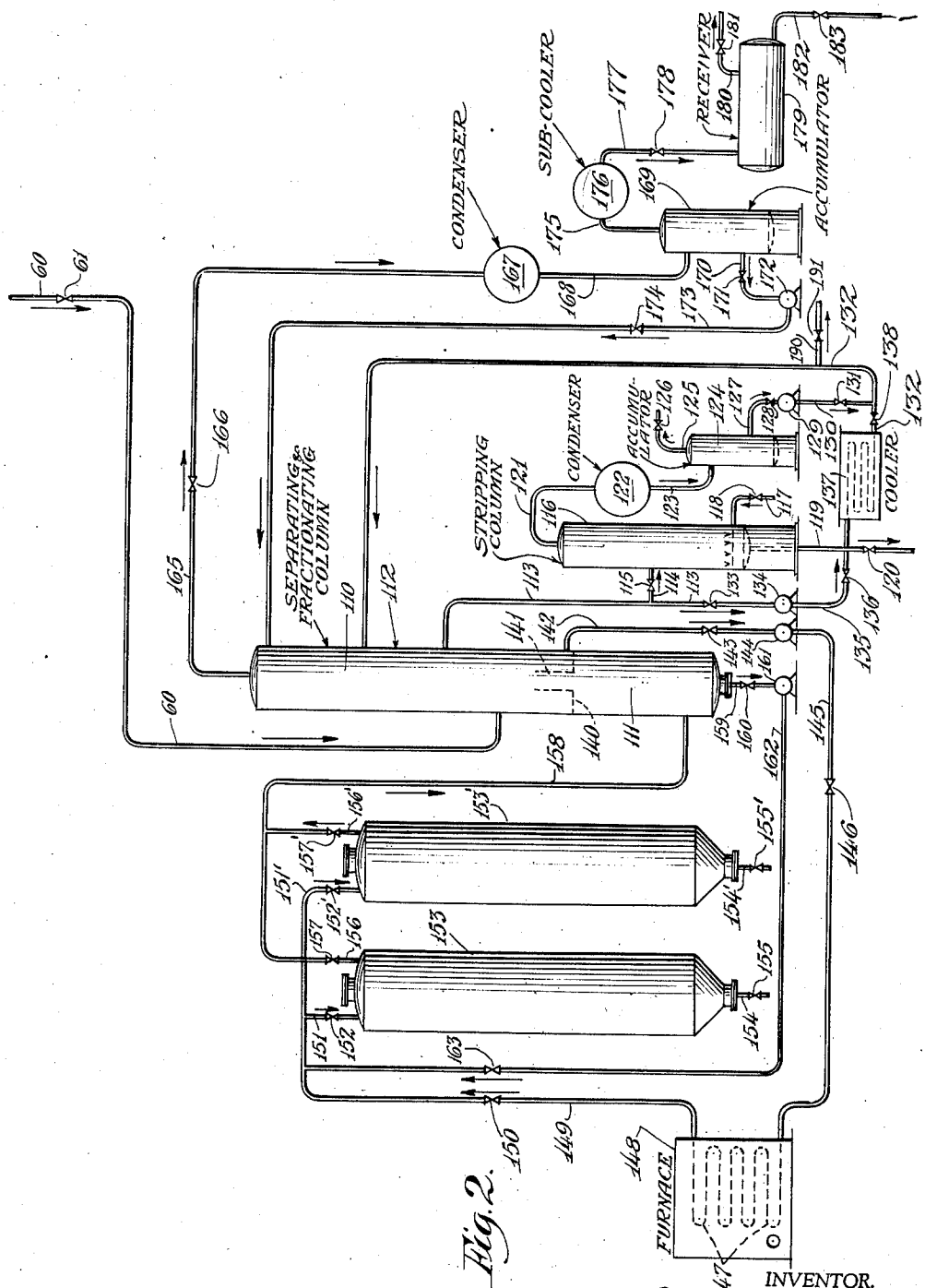


Fig. 2.

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Patented Oct. 31, 1944

2,361,891

UNITED STATES PATENT OFFICE

2,361,891

CONVERSION OF HYDROCARBON OILS

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Application September 26, 1940, Serial No. 358,408

2 Claims. (Cl. 196—49)

The invention relates to an improved process for the pyrolytic conversion of relatively high-boiling hydrocarbon oil such as heavy crude petroleum, topped crude and the like, to produce therefrom high yields of light distillate such as good antiknock gasoline and minor yields of petroleum coke. Normally gaseous products containing a high percentage of readily polymerizable olefins, such as propene and butenes, are also produced within the system and, in the preferred embodiment of the invention, intermediate liquid products such as good quality furnace oil, naphtha and the like are recovered as separate products of the process.

A number of novel features are provided by the invention which represent advantageous departures from prior practice, particularly in view of their interdependent and cooperative relationship. The invention also resides in various combinations of these features involving less than the entire combination disclosed and it is therefore not intended to limit the invention to this entire combination.

In accordance with one specific embodiment of the invention, the hydrocarbon oil charging stock to be cracked is preheated, as will be later described, and thence supplied to and through a heating coil wherein it is brought to the desired cracking temperature at substantial superatmospheric pressure and wherein a portion of the cracking reaction occurs. The resulting heated products are passed downwardly through an elongated vertically disposed reaction chamber also maintained at a cracking temperature and substantial superatmospheric pressure wherein the desired cracking reaction is substantially completed. Vaporous and liquid conversion products are separated in the lower portion of the reaction chamber and separately removed therefrom. The charging oil is passed in indirect heat transfer relation with said vaporous products and then in indirect heat transfer relation with said liquid products to preheat the same prior to its introduction into the heating coil and the resulting partially cooled products are supplied to a vaporizing and fractionating column, maintained at a super-atmospheric pressure lower than that employed in the reaction chamber, from which fractionating column the overhead vaporous stream consisting essentially of gasoline and normally gaseous fractions is supplied to condensing and recovery equipment. Unvaporized components of the conversion products and condensate formed in the fractionating column are supplied to another vaporizing and fractionating column operated at substantially reduced pressure from which latter column a light overhead distillate, such as naphtha, and a select intermediate fraction, such as furnace oil, are separately recovered, while the bottoms comprising higher boiling components of the materials supplied to this zone are directed to a third fractionating column from which another overhead distillate product and a select side-stream comprising good quality light fuel oil are separately recovered. The bottoms from the third fractionating column are supplied to another heating coil wherein they are quickly heated under non-coking conditions to a temperature adequate to induce their subsequent reduction to coke in alternately operated enlarged coking chambers to which the heated products from this coil are supplied. Vapors evolved in the coking chamber are supplied to a separating chamber wherein high coke-forming components unsuitable for treatment in the last named heating coil are separated from the lighter vapors, these heavy components being returned directly to the coking chambers while vapors from the separating chamber are supplied to the last named fractionating column.

Referring to Figs. 1 and 2 of the drawings, which diagrammatically illustrate means for carrying out the invention, the preheated charging stock is supplied, as will be later described, to heating coil 1 disposed in furnace 2 and in passing therethrough is heated to the desired cracking temperature at substantial superatmospheric pressure. The resulting heated products are directed from coil 1 through line 3 and valve 4 into reaction chamber 5 which is also maintained at substantial superatmospheric pressure and which is preferably insulated to conserve heat, although insulation is not shown in the drawings, so that cracking of the heated products from coil 2 is continued in the reaction chamber.

The rough separation of vaporous and liquid conversion products is effected in the lower portion of chamber 5 and the liquid products are directed from the bottom of the chamber through line 6, valve 7, heat exchanger 8, line 9 and valve 10 into the vaporizing and separating section 11 of column 12, of which the upper portion 13 is a fractionator. The vaporous conversion products are separately removed from chamber 5 above the point of removal of the liquid products in this zone and are directed through line 14, heat exchanger 15, line 16 and valve 17 also into zone 11. In the case here illustrated, the streams of vapors and liquid products separately removed

from chamber 5 are commingled after they have passed through heat exchangers 15 and 8, respectively, and before they are introduced into zone 11, although it is entirely within the scope of the invention to separately supply the vaporous and liquid products to the latter zone when desired.

The function of heat exchangers 8 and 15 is to separately cool the vaporous and liquid streams supplied, respectively, to these zones to a temperature at which no substantial further cracking of these materials will occur, this being accomplished, in the case here illustrated, by passing the separate streams in indirect heat transfer relation with the charging oil which is thereby preheated. I have found that the feature of separating the vaporous and liquid conversion products in the reaction chamber and separately cooling the same in transit to the subsequent vaporizing and separating step is particularly advantageous as compared with removing them in commingled state from the reaction chamber and effecting their cooling in commingled state. Due to this separation and separate cooling, the formation and deposition of coke during the transfer of the conversion products from the reaction chamber to the subsequent vaporizing and separating step is practically eliminated, thus greatly prolonging the duration of the operating cycle of the process.

A substantial superatmospheric pressure is also employed in column 12 but is preferably somewhat lower than the pressure utilized in the reaction chamber. The vapors supplied to and evolved in zone 11 pass therefrom through vapor riser 17 into fractionating section 13 of column 12 wherein they are fractionated to form light and heavy condensates and fractionated vapors of the desired end boiling point. The heavy condensate formed by fractionation of the vapors and collected above the tray or deck 18, which forms a partition between zones 11 and 13, is directed through line 19 and valve 20 to pump 21 wherefrom it is supplied through line 22 and valve 23 to heat exchanger 24, cooled in the latter zone, as will be later described, and thence directed through line 25 wherefrom it is supplied, in part, through valve 26 into fractionator 13 wherein it serves as a cooling and refluxing medium and, in part, through line 27, valve 28 and a suitable spray device indicated at 29 into the lower section 11 of the column wherein it contacts and acts as a cooling medium for the vapors supplied to and evolved in this zone and, in part, commingles with the liquid products removed from the lower portion of zone 11. Relatively heavy liquid conversion products which remain unvaporized in zone 11 are directed therefrom through line 30 and valve 31 to fractionator 34.

The vapors remaining uncondensed in the lower portion of fractionator 13 are further fractionated in the upper portion of this zone to form a lighter condensate which is removed therefrom through line 32 and may be directed, all or in part, through valve 33 in this line to fractionator 34 or returned, all or in part, via line 35, valve 36, pump 37, line 38 and valve 39 to heating coil 1 for further cracking in this zone in commingled state with the charging oil.

Fractionated vapors of the desired end-boiling point, which preferably consist predominantly of gasoline and normally gaseous products, are directed from the upper portion of fractionator 13 through line 40 and valve 41 to cooling and condensation in condenser 42 wherefrom the resulting distillate and uncondensed gases and vapors are directed through line 43 and valve 44 to accumulator 45. Condensate collected in accumulator 45 is returned in regulated quantities through line 46, valve 47, pump 48, line 49 and valve 50 to the upper portion of fractionator 13 to serve as a cooling and refluxing medium in this zone. Vapors and gases which remain uncondensed in accumulator 45 are directed therefrom through line 51 and valve 52 to sub-cooler 53, wherein condensation of substantially all of the normally liquid components of the vapors is completed. The resulting distillate and uncondensed gases are directed from sub-cooler 53 through line 54 to receiver or separating drum 55 wherefrom the gases are released through line 56 and valve 57 to storage or suitable absorption equipment, not illustrated, or elsewhere as desired, while the distillate which will normally contain substantial quantities of dissolved gases is supplied through line 58 and valve 59 to suitable stabilizing equipment, not illustrated, or to any other required further treatment or storage.

Due to the relatively high pressure employed in column 12, the stream removed therefrom through line 32 will contain substantial quantities of gasoline or heavy gasoline fractions and will also contain heavy fractions undesirable as components of the light furnace oil product of the operation. Also, the heavier liquid fractions removed from the lower portion of zone 11 will normally include some gasoline or heavy gasoline fractions and a substantial quantity of low-boiling fractions desirable for inclusion in the light furnace oil. By substantially reducing the pressure in chamber 34 and supplying both of these streams from column 11 to this zone, they are subjected to revaporization and fractionation in this zone to effect a better segregation of the desired products and, in addition to the vaporization effected in this zone by the pressure reduction, heat in the vapors evolved from the hot heavy fractions from zone 11 serves to effect vaporization of the lighter condensate from fractionator 13 by intimate countercurrent contact therewith in fractionator 34, while the lighter condensate serves to partially cool and assist fractionation of said vapors evolved from the heavier oil. The bottoms which remain unvaporized in fractionator 34, together with the heavy condensate collected in the lower portion of this zone, are removed therefrom through line 60 and directed through valve 61 in this line into column 12, the function of which will be later explained.

A side-stream comprising the desired light furnace oil and some undesired lower boiling components is removed from a suitable intermediate point in fractionator 34 through line 65 and is directed, in part, through valve 66 in this line to heat exchanger 67 wherein it is cooled and wherefrom it is thence returned through line 68 and valve 69 to fractionator 34 to serve as a cooling and refluxing medium in this zone. The remaining portion of the side-stream from line 65 is directed through lines 70 and valve 71 to stripping column 72 wherein it is reboiled in any suitable well known manner for the purpose of substantially freeing the same of undesired light fractions. Reboiling and stripping is accomplished, in the particular case here illustrated, by supplying open steam to column 72 through line 73 and valve 74, although reboiling may be accomplished, when desired, by the use of an

indirect heat exchange medium such as steam or hot oil. The vapors evolved in column 72 are returned therefrom through line 75 to fractionator 34 and the desired light furnace oil product is directed from the lower portion of this zone through line 76 and valve 77 to cooling and storage or elsewhere, as desired.

Fractionated vapors of the desired end-boiling point, which, in addition to any normally gaseous fractions, may constitute a special naphtha product or additional yields of gasoline or heavy gasoline fractions, are directed from the upper portion of fractionator 34 through line 78 and valve 79 to cooling and condensation in condenser 80 wherefrom the resulting distillate and uncondensed gases are directed through line 81 and valve 82 to collection and separation in receiver 83. The uncondensed gases are released from the receiver through line 84 and valve 85 to storage or elsewhere, as desired, and regulated quantities of the distillate collected in the receiver are preferably returned by means of line 86, valve 87, pump 88, line 89 and valve 90 to the upper portion of fractionator 34 to serve as a cooling and refluxing medium in this zone. The net make of the distillate collected in receiver 83 is directed therefrom through line 91 and valve 92 to pump 93 and when this material is desired as a separate product of the process it may be directed through line 94, line 95 and valve 96 to storage or to any desired further treatment or, when this material comprises gasoline or gasoline fractions suitable for inclusion with the gasoline in the overhead vaporous stream from fractionator 13, it may be supplied from pump 93 through line 94, line 98 and valve 97 to sub-cooler 53 wherein it commingles with the uncondensed stream from accumulator 45 and wherein the distillate from receiver 83 will normally serve as an absorbent for some of the heavy gases in said uncondensed stream, the resulting commingled distillate being collected in receiver 55 and therein separated from the uncondensed and undissolved gases.

Charging stock for the process, which may comprise any desired type of oil but preferably consists of relatively heavy petroleum fractions, such as topped or reduced crude, is supplied through line 100 and valve 101 to pump 102 wherefrom it is supplied to heating coil 1 after first passing, in the particular case here illustrated, through each of the heat exchangers 67, 24, 15 and 8, in series, and serves in each of these zones as a cooling medium for the relatively hot materials supplied thereto, as previously described, by passing in indirect heat exchange relation therewith. From pump 102, the charging oil is directed, in the particular case here illustrated, through line 103 to heat exchanger 67, thence through line 104 to heat exchanger 24, thence through line 105 to heat exchanger 15, thence through line 106 to heat exchanger 8 and finally through line 107 and valve 108 into coil 1.

It will, of course, be understood, that any other desired method and means of preheating the charging oil may be employed within the scope of the invention or that it may, when desired, be supplied to coil 1 without preheating or that any of the heat exchangers 8, 15, 24 and 67 may be employed for preheating the charging stock without necessarily using all of them for this purpose. For any of the heat exchangers not utilized to preheat the charging oil a suitable cooler of any conventional form may be substituted or another cooling medium may be utilized therein without departing from the scope of the invention.

The bottoms supplied from fractionator 34 to the fractionating section 110 of column 112 commingle in this zone with vaporous products of the coking operation which are supplied to fractionator 110, as will be later described, and the mixture is separated into relatively light, relatively heavy and intermediate fractions. The relatively light fractions which comprise the overhead vaporous stream from fractionator 110, consisting essentially of gasoline and normally gaseous fractions, are derived predominantly from the vaporous products of the coking operation, while the heavy and intermediate liquid fractions are derived from both the vaporous products of the coking operation and the bottoms from fractionator 34.

The intermediate fractions, which preferably comprise a good quality fuel or furnace oil, are removed from an intermediate point in fractionator 110 through line 113 and are directed, all or in part, through line 114 and valve 115 to stripping column 116 wherein they are substantially freed of undesired light fractions, this being accomplished, in the case here illustrated, by reboiling with open steam which is supplied to the lower portion of the column through line 117 and valve 118. The stripped product is removed from the lower portion of the column through line 119 and valve 120 to cooling and storage or elsewhere, as desired, and the evolved vapors and gases may be returned directly from column 116 to fractionator 110 by well known means, not illustrated, or, preferably, in order that a reduced pressure relative to that employed in fractionator 110 may be utilized in column 116 to assist vaporization in this zone, the vapors evolved from the upper portion of this zone may be directed through line 121 to condenser 122 wherefrom the resulting distillate is directed through line 123 to accumulator 124. Any uncondensed and undissolved gases are released from accumulator 124 through line 125 and valve 126 and the distillate from this zone is returned by means of line 127, valve 128, pump 129, line 130, valve 131 and line 132 to a suitable intermediate point in fractionator 110 above the point of removal of said intermediate fraction therefrom, to serve as a cooling and fluxing medium in this zone. To augment the distillate supplied from accumulator 124 to fractionator 110 and provide additional cooling and refluxing in the latter zone, when desired, provision is made for directing a regulated portion of the unstripped side-stream from fractionator 110 through valve 133 in line 113 to pump 134 by means of which it is returned via line 135, valve 136, cooler 137, line 132 and valve 138 to fractionator 110. A portion or all of the side stream removed from column 110 may, when desired, be recovered without first stripping the same in column 116, this being accomplished by directing the same, after cooling in cooler 137, to storage or elsewhere as desired, through line 190 and valve 191 communicating with line 132.

The high-boiling components of the materials supplied to fractionator 110 constitute a heavy but relatively clean oil suitable for further cracking and reduction to coke to produce additional yields of gasoline and intermediate and heavy liquid fractions. This material accumulates in the lower portion of fractionator 110 above partition 140, which separates the fractionating section of the column 112 from its lower portion 111,

and is directed therefrom through line 142 and valve 143 to pump 144 by means of which it is supplied through line 145 and valve 146 to heating coil 147.

Coil 146 is disposed in furnace 148 which, although illustrated in a conventional manner in the drawings, preferably consists of one of the several well known forms of heaters designed to transfer heat to the oil at high rates so that the heavy oil may be quickly heated in coil 147 to a high temperature which will induce cracking and effect subsequent reduction of the heavy conversion products to coke without allowing the oil to remain in the heating coil for a sufficient length of time to cause coking difficulties therein. A substantial superatmospheric pressure is preferably employed at the outlet of coil 147 and the highly heated oil from this zone is directed through line 149 and valve 150 into a plurality of alternately operated coking chambers.

Two substantially identical coking chambers 153 and 153' are illustrated in the drawings, but it will, of course, be understood that any desired number of such zones may be utilized. Heated oil from line 149 is supplied to chamber 153 through line 151 and valve 152 and to chamber 153' through line 151' and valve 152'. The coking chambers are preferably unheated and insulated, although insulation is not indicated in the drawings, and the coke which forms in these zones as the result of distillation and cracking of the heated oil therein is allowed to accumulate in the coking chamber in operation until it is substantially filled or until its operation is completed for any other reason, following which the heated oil stream is diverted to the other chamber and the accumulated coke is removed from the first mentioned chamber in any well known manner, not illustrated, preferably after it has been isolated from the rest of the system. Coking chambers 153 and 153' are provided with drain lines 154 and 154', respectively, controlled by the respective valves 155 and 155' and these lines may also serve as a means of introducing steam, water or other suitable cooling material into each of the chambers after its operation has been completed in order to hasten cooling and facilitate removal of the coke.

Vapors evolved in chambers 153 and 153' are removed therefrom through the respective lines 156 and 156', controlled by the respective valves 157 and 157', and are thence directed through line 158 to separating zone 111 of column 112 wherein heavy pitch or tar-like materials carried over with the vapors from the coking zone are removed therefrom prior to their fractionation for the formation of the heavy condensate supplied to coil 147. The vapors substantially freed of entrained, undesirable heavy materials pass from zone 111 through vapor riser 141 into fractionator 110. The heavy tar or pitch-like materials removed from the vapors are, due to their high coke-forming characteristics, unsuitable for treatment in coil 147 and are, therefore, returned directly to the coking chambers for further treatment without passing through coil 147, this being accomplished by removing the same from the lower portion of zone 111 through line 159 and valve 160 to pump 161 wherefrom they are returned through line 162 and valve 163 to line 149 and thence to the coking chamber in operation.

The fractionated vaporous stream removed from the upper portion of fractionator 110 is directed through line 165 and valve 166 to cooling and partial condensation in condenser 167 wherefrom the resulting distillate and uncondensed vapors and gases are directed through line 168 to accumulator 169, wherefrom the condensate is returned in regulated quantities by means of lines 170, 171, pump 172, line 173 and valve 174 to the upper portion of fractionator 110 to serve as a cooling and refluxing medium in this zone. The vapors and gases which remain uncondensed in accumulator 169 are directed therefrom through line 175 to sub-cooler 176 wherein condensation of substantially all of their normally liquid components is completed to form a distillate boiling within the range of gasoline and containing substantial quantities of dissolved heavy gases. The resulting distillate and remaining uncondensed and undissolved gases are directed from sub-cooler 176 through line 177 and valve 178 to collection and separation in receiver 179 wherefrom the uncondensed gases are directed to storage or to suitable absorption equipment, not illustrated, through line 180 and valve 181, while the distillate from this zone is removed through line 182 and valve 183 to stabilization and/or to any other desired treatment, not illustrated, or to storage.

The operating conditions employed in various portions of the system will vary considerably depending upon the nature of the charging stock employed and the desired characteristics of the products. In general, however, when the charging stock is a relatively heavy oil, such as topped or reduced crude, a cracking temperature of from 850 to 950° F., or thereabouts, is employed at the outlet of coil 1, preferably with a superatmospheric pressure at this point in the system of 200 pounds, or more, per square inch. A pressure of substantially the same magnitude or somewhat lower is preferably employed in reaction chamber 5 and the vaporous and liquid conversion products separately removed from this zone are preferably cooled to a temperature of from 800 to 850° F., prior to their introduction into column 12. A substantial superatmospheric pressure of from 150 to 200 pounds, or thereabouts, per square inch is preferably employed in column 12, but to assist vaporization in the lower portion of this zone the pressure employed therein is preferably somewhat lower than that utilized in the reaction chamber. A still lower pressure ranging, for example, from 30 to 150 pounds or thereabouts, per square inch, superatmospheric, is preferably employed in fractionator 34. A temperature of from 900 to 950° F. is preferably employed at the outlet of heating coil 147, preferably with a superatmospheric pressure at this point in the system of from 90 to 150 pounds, or thereabouts, per square inch. Substantially the same or somewhat lower superatmospheric pressure may be employed in the succeeding coking chambers and column 112 is preferably operated at substantially the same pressure as that employed in the coking zone, this pressure preferably also being substantially equalized in the succeeding condensing and collecting equipment for the overhead vaporous stream from column 110, while substantially the same or, preferably, a somewhat lower pressure may be employed in stripping column 116.

As an example of one specific operation of the process herein provided, as it may be conducted in an apparatus of the character illustrated and above described, the charging stock is a West

Texas reduced crude of approximately 22° A. P. I. and is supplied to the system at approximately 18,200 barrels per day. It is preheated in passing through heat exchangers **67**, **24**, **15** and **8**, in series, to a temperature of approximately 300° F. and is further heated in coil **1** to an outlet cracking temperature of approximately 920° F. with a superatmospheric pressure at the outlet of this coil of approximately 265 pounds per square inch. Substantially the same pressure is employed in the reaction chamber and the vaporous and liquid conversion products separately withdrawn from this zone are each separately cooled by indirect heat exchange with the charging stock to a temperature of approximately 830° F., at which they enter section **11** of column **12**.

A superatmospheric pressure of approximately 160 pounds per square inch is employed in column **12** and condensate removed from the lower portion of fractionator **13** at a temperature of approximately 700° F. is cooled to a temperature of approximately 500° F. and returned, in part, to section **11** and, in part, to fractionating section **13** of column **12** in the manner illustrated.

Approximately 12,000 barrels per day of approximately 20° A. P. I. gravity liquid conversion products are removed from the lower portion of section **11** of column **12** at a temperature of approximately 790° F. and supplied to fractionator **34** at a relatively low point in this zone. Approximately 2450 barrels per day of condensate having a gravity of approximately 38.5° A. P. I. is removed from an intermediate point in fractionator **13** at a temperature of approximately 625° F. and also supplied to fractionator **34** at a relatively high point in this zone.

The overhead vaporous stream from fractionator **13** is cooled in condenser **42** to a temperature of about 180° F. and resulting condensate is returned from accumulator **45** to the upper portion of fractionator **13**. A temperature of approximately 100° F. is employed in sub-cooler **53** and receiver **55** is operated at a superatmospheric pressure of about 150 pounds per square inch.

Fractionator **34** is operated at a superatmospheric pressure of about 40 pounds per square inch and bottoms of approximately 16° A. P. I. gravity are removed from this zone at a temperature of approximately 710° F. and supplied therefrom to fractionator **110** at the rate of approximately 9600 barrels per day. The stripped side-stream recovered from column **72** is a furnace oil of about 32° A. P. I. gravity and amounts to approximately 5400 barrels per day. The gas removed from receiver **83** amounts to approximately 300 pounds per hour and approximately 1050 barrels per day of 48° A. P. I. gravity naphtha are recovered from receiver **83**.

Heating coil **147** employs an outlet cracking temperature of approximately 945° F. with a superatmospheric pressure at this point in the system of approximately 150 pounds per square inch. Substantially the same pressure is employed in the succeeding alternately operated coking chambers and the vapors which leave the coking zone at a temperature of approximately 885° F. are supplied to the lower portion of column **112** at the rate of approximately 218,000 pounds per hour. The heavy oil supplied from the lower portion of fractionator **110** to heating coil **147** amounts to approximately 16,800 barrels per day and has an A. P. I. gravity of approximately 12°. The heavier high coke-forming materials supplied directly from the lower portion of column **112** to the coking zone has an A. P. I. gravity of approximately 5° and amounts to approximately 800 barrels per day. The side-stream removed from fractionator **110** has an A. P. I. gravity of approximately 29° and is withdrawn from this zone at a temperature of approximately 625° F. A portion of this material is cooled to a temperature of approximately 200° F. and returned to an immediate point in fractionator **110**, while the remaining portion which amounts to approximately 4000 barrels per day is recovered as stock for further cracking in another cracking unit. The overhead vaporous stream from fractionator **110** is cooled in condenser **167** to a temperature of about 180° F., the temperature being reduced in sub-cooler **176** to approximately 100° F. and a superatmospheric pressure of about 130 pounds per square inch being employed in receiver **179**. Distillate from accumulator **169** is returned from the upper portion of fractionator **110** as a cooling and refluxing medium. Approximately 11,500 pounds per hour of uncondensed gases are recovered from receiver **179** and the unstabilized gasoline recovered from this zone amounts to approximately 3,460 barrels per day and has an A. P. I. gravity of approximately 69.5°.

The yields of the various products, based on reduced crude charged to the system, are approximately as follows:

Cracking section

Product	Yields	
	Per cent by wt.	Per cent by vol.
Gasoline (400° F. E. P.—10 #R. V. P.)	14.2	17.
Furnace oil (stripped side stream from col. 72)	28.0	29.
Residuum (to cooking sect.)	54.9	52.7
Gas and loss	2.9	

Coking section

Product	Yields	
	Per cent by wt.	Per cent by vol.
Gasoline (400° F. E. P.—10 #R. V. P.)	12.6	15.7
Unstripped side stream from Fract. 112	21.4	22.0
Coke	14.3	
Gas and loss	6.6	

I claim as my invention:

1. A process of hydrocarbon oil conversion which comprises treating said oil at a cracking temperature and substantial superatmospheric pressure in a heating coil and communicating enlarged reaction chamber, supplying resulting vaporous and liquid conversion products to a vaporizing and fractionating zone operated at reduced superatmospheric pressure and therein separating them into heavy liquid fractions, lighter condensate and a fractionated vaporous stream consisting essentially of gasoline and gases, subjecting the vaporous stream to condensation and the resulting distillate and uncondensed gases to separation, separately supplying said heavy liquid fractions and lighter condensate, each without intentional cooling thereof, to another vaporizing and fractionating zone operated at substantially lower pressure than that employed in the first mentioned vaporizing and fractionating zone, therein effecting further vaporization of said residual liquid by virtue of its contained heat and the reduced pressure and

further vaporizing said lighter condensate with the assistance of heat derived from said residual liquid, removing as fractionated vapors from the last describing vaporizing and fractionating zone an overhead stream comprising gasoline fractions of higher end-boiling point than those recovered from the first mentioned fractionating step, condensing and recovering the same, supplying flash distilled and reduced residual liquid from the last described vaporizing and fractionating zone to a third fractionating step, supplying bottoms from the third fractionating step to a separate heating coil, therein heating the same to cracking temperature under non-coking conditions, introducing heated products from the last named coil into a coking zone and therein reducing their high-boiling components to coke, separating any undesirable heavy components from the vaporous products of the coking operation, supplying resulting relatively clean vaporous products of the coking operation to said third fractionating step, therein separating from the materials supplied thereto said bottoms supplied to the heating coil of the coking system, a lighter condensate suitable for further cracking and a fractionated vaporous stream consisting essentially of gasoline and gases, subjecting the latter to condensation and recovering the resulting distillate and uncondensed gases.

2. The process of hydrocarbon oil conversion which comprises cracking an oil at a cracking temperature and substantial superatmospheric pressure in a heating coil, passing resulting heated products downwardly through an enlarged vertically disposed reaction chamber also maintained at cracking temperature and substantial superatmospheric pressure, separating the resulting products into predominantly vaporous and predominantly liquid fractions in the lower portion of the reaction chamber and removing the same as separate streams therefrom, separately cooling each of said streams to a temperature at which substantial further cracking thereof is prevented, supplying both of the cooled streams to a vaporizing and fractionating zone operated at lower pressure than that employed in the reaction chamber, therein separating the vaporous and liquid fractions into residual liquid, lighter condensate containing high boiling gasoline fractions and a fractionated vaporous stream consisting essentially of gasoline and gases, subjecting the latter to condensation and recovering the resulting distillate and uncondensed gases, supplying said lighter condensate to a second vaporizing and fractionating zone, separately supplying said residual liquid, without intentional loss of heat, to a lower point in the second vaporizing and fractionating zone, substantially reducing the pressure employed in the latter zone relative to that employed in the first mentioned vaporizing and fractionating zone, therein effecting further vaporization of the residual liquid and supplying heat from the evolved vapors to said lighter condensate to further vaporize the same and evolve said heavy gasoline fractions therefrom, recovering from an intermediate point in the second fractionating zone a heavier condensate substantially devoid of fractions boiling within the range of the desired gasoline product of the process, removing as fractionated vapors from the second vaporizing and fractionating zone an overhead stream comprising gasoline of higher end-boiling point than that recovered from the first mentioned fractionating zone, condensing and recovering the same, removing the resulting flash distilled and reduced residual liquid from the lower portion of the second vaporizing and fractionating zone and supplying the same to a third fractionating zone, supplying bottoms from the third fractionating zone to a separate heating coil, therein heating the same to cracking temperature under non-coking conditions, discharging the resulting heated products into an enlarged coking zone and therein reducing their high boiling components to coke, separating undesirable heavy components from the vaporous products of the coking operation and supplying the remaining relatively clean vaporous products to said third fractionating zone, separating from the materials supplied to the latter zone said bottoms supplied to the heating coil of the coking system, a light condensate suitable for further cracking and a fractionated vaporous stream consisting essentially of gasoline and gases, subjecting the latter to condensation and recovering the resulting distillate and uncondensed gases.

KENNETH M. WATSON.