Oct. 22, 1935. P. H. SULLIVAN 2,017,874

TREATMENT OF HYDROCARBONS

Filed Oct. 26, 1934 2 Sheets-Sheet 1

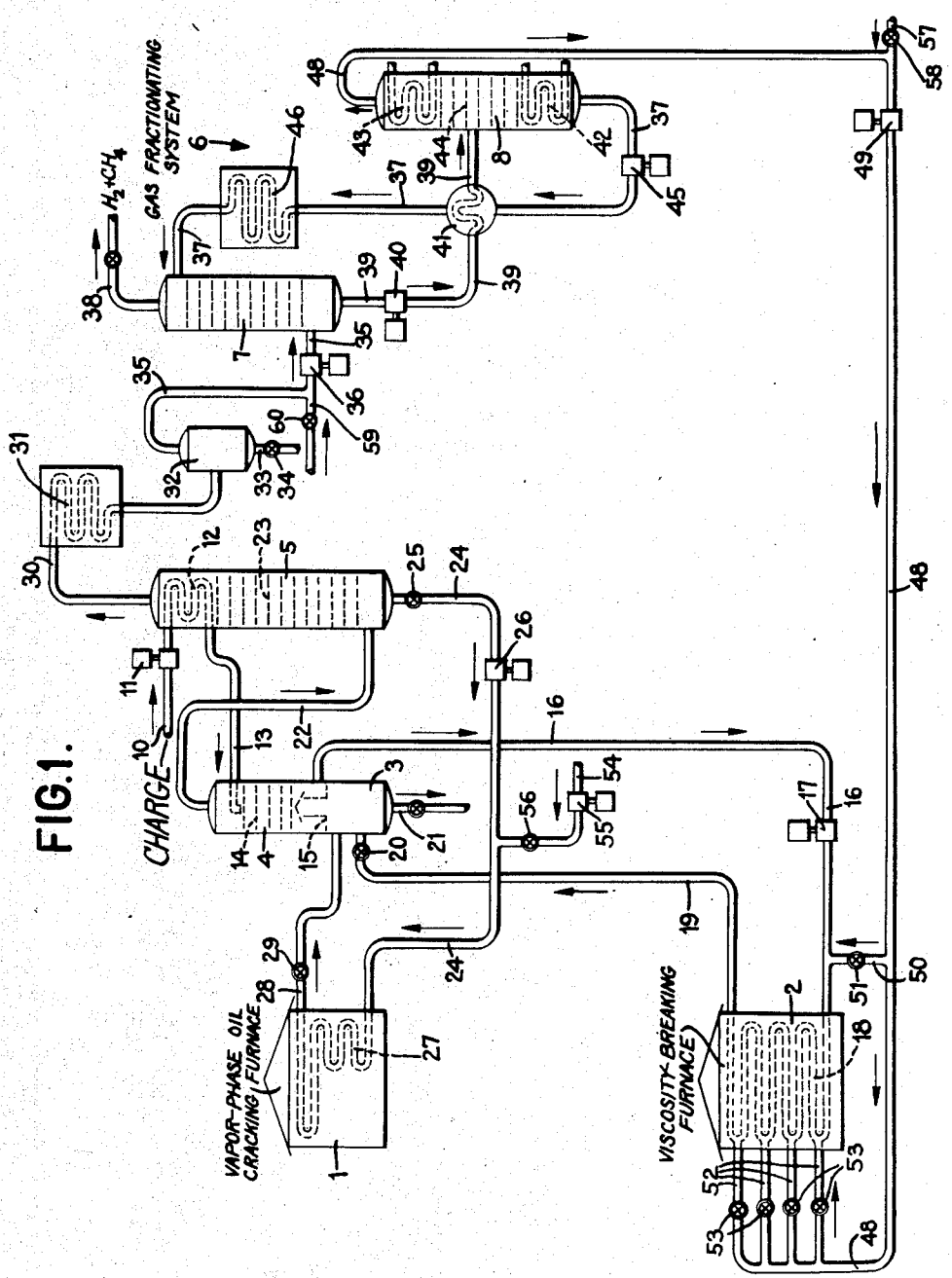


FIG.1.

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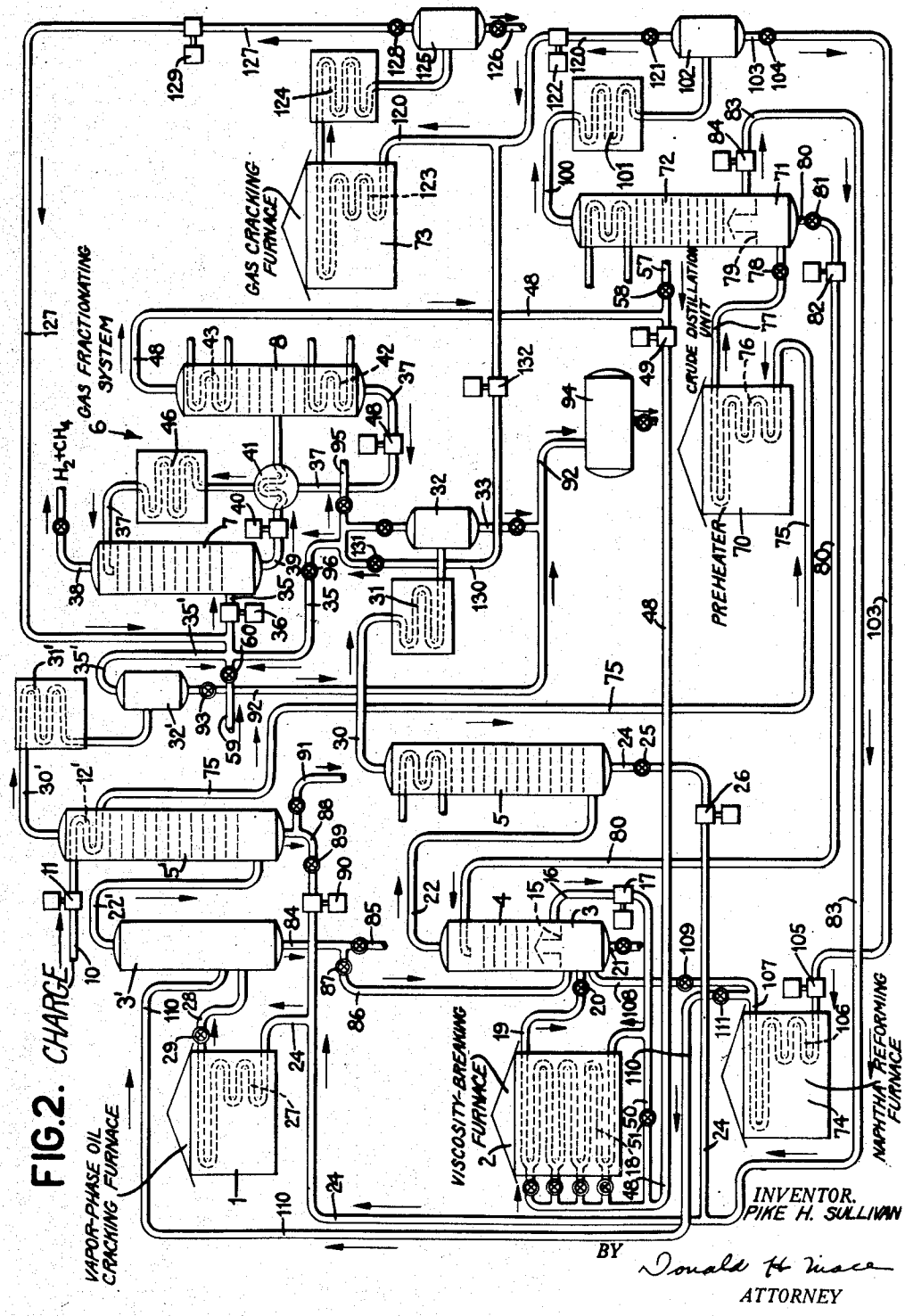


FIG. 2.

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UNITED STATES PATENT OFFICE

2,017,874

TREATMENT OF HYDROCARBONS

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Application October 26, 1934, Serial No. 750,030

8 Claims. (Cl. 196—9)

My invention relates to the thermal treatment of hydrocarbons and more particularly to a process for converting hydrocarbon oil and hydrocarbon gas into relatively low-boiling hydrocarbon oil suitable for use as motor fuel.

My invention has an especial relation to oil-cracking processes of the so-called "combination-unit" type in which a heavy hydrocarbon oil, such, for example, as reduced crude, containing residual constituents, is subjected to a comparatively mild cracking temperature under superatmospheric pressure for the purpose of producing a clean condensate suitable as a charging stock for a vapor-phase cracking operation, the products of the mild cracking operation being fractionated to recover clean condensate, the clean condensate being separately subjected to more drastic cracking conditions, preferably in the vapor phase, and the products being fractionated to recover gases, naphtha or gasoline and tars.

It has previously been proposed in the operation of oil-cracking units to recycle gases produced in the cracking operation to some point in the cracking operation, sometimes with additional heating of the gases, in order that the heated gases may serve as a convection medium to assist in the cracking and distilling operation. Vapor-phase cracking conditions such as those commonly employed today are not, however, especially conducive to the polymerization of gaseous olefins. On the contrary, the present tendency toward carrying out vapor-phase operations at increasingly high temperatures leads to the production of increasing quantities of fixed gases, these gases being relatively highly unsaturated in character, that is to say containing increasingly large amounts of gaseous olefins.

My invention therefore has for an object the provision of a process of the so-called "combination-unit" type wherein gases produced in the cracking of hydrocarbon oil may be caused to be in part reconverted or polymerized to low-boiling normally liquid products useful as motor fuel and of very high anti-knock value.

My invention has for a further object the provision of a process wherein a gas-polymerization operation may advantageously be conducted in conjunction with, or as a part of, an oil-cracking operation of the general character indicated hereinabove, with a minimum of additional equipment and difficulty and with marked advantage to the operator.

According to my invention, gases produced in the cracking of hydrocarbon oil in a combination unit of the character generally indicated hereinabove, together if desired with hydrocarbon gas from an additional source such as unsaturated gases produced by cracking gases liberated in the distillation of crude petroleum, are fractionated to separate hydrogen and methane and to effect a concentration of gaseous olefins and the thus concentrated gases are returned to the so-called "viscosity-breaking" zone of the combination operation, that is to say to that zone wherein a heavy oil stock such as reduced crude which is unsuitable for vapor-phase cracking operations is subjected to a comparatively mild cracking temperature, preferably under superatmospheric pressure, to effect the production of clean charging stock suitable for separate vapor-phase cracking. I have found that the conditions under which such "viscosity-breaking" operations are conducted are much more effective insofar as the polymerization of gaseous olefins to normally liquid low-boiling hydrocarbon oils is concerned than are the conditions under which vapor-phase cracking of clean stocks is conducted.

My invention further contemplates the recovery of the products of gas polymerization along with such gasoline as may be produced in the viscosity-breaking operation and in some instances with reformed gasoline or gasoline produced by the vapor-phase cracking of hydrocarbon oil or both.

My invention further contemplates a combined operation in which crude petroleum is separated into gases, naphtha, gas oil and residual products, the gas oil being delivered to the vapor-phase cracking stage of a combination unit of the character indicated, reduced crude being delivered to the viscosity-breaking stage of the same unit and the naphtha, if desired, being subjected to reformation in a separate cracking coil with the discharge of the reformed products into the system at a convenient point, and with the delivery of the gases produced in the distillation of crude petroleum, preferably after cracking and fractionation to increase their olefin content, to the viscosity-breaking stage along with fractionated gases recovered from the vapor-phase cracking and reforming operations.

My invention further contemplates and has for further objects such additional operative advantages and improvements as may hereinafter be found to obtain.

In order that my invention may be more clearly set forth and understood, I now describe, with reference to the accompanying drawings forming a part of this specification, various preferred forms and manners in which my invention may be practiced and embodied. In these drawings,

Fig. 1 is a more or less diagrammatic elevational view of apparatus for carrying out an oil-cracking and gas-polymerizing operation in accordance with my invention, the view being intended to serve as a flow diagram of one modification of my process; and

Fig. 2 is a similar view of an alternative form of apparatus for practicing my invention in various other modifications thereof.

Similar reference numerals designate similar parts in each of the views of the drawings.

Referring now to the drawings, and more particularly to Fig. 1, I have shown a so-called "combination unit" comprising in part a high-temperature or vapor-phase oil-cracking furnace 1, a viscosity-breaking furnace 2 intended to operate at a lower temperature than the furnace 1, an evaporator 3, a primary fractionator 4, a secondary fractionator 5 and a gas-fractionating system indicated generally by the reference numeral 6 and comprising principally an absorber 7 and a stripper 8.

A suitable charging stock, such, for example, as a reduced crude, is introduced into the system through a line 10 by means of a pump 11, passing first through a heat-exchange coil 12 in the upper portion of the secondary fractionator 5, and then passing by way of line 13 into the upper portion of the primary fractionator 4, the interior of which may be provided with trays or baffles 14 and which receives hot cracked vapors from the evaporator 3 through a trap-out tray 15. In the primary fractionator 4, a partial distillation and a further heating of the charging stock takes place, residual constituents being withdrawn from the trap-out tray 15 through a line 16 wherein is located a pump 17 which serves to force the oil through a pipe coil 18 located in the furnace 2.

The temperatures and pressures which are maintained at the outlet of the coil 18 may vary considerably but are generally within what may be called a viscosity-breaking range, that is to say a range of temperature and pressure primarily intended to effect a conversion of the relatively heavy oil to lighter constituents suitable for further cracking under vapor-phase conditions to produce gasoline and distinguished from more drastic cracking conditions intended to produce large quantities of gasoline in a single operation.

While these temperatures may vary considerably, as will be appreciated by those skilled in the art, in accordance with the character of the charging stock and the nature of the results desired as well as the time of treatment, I prefer to employ temperatures of from about 800° to about 925° F., and more specifically, from 850° to 875° F. The pressure may vary over a very wide range but, in any event, is not less than 200 pounds per square inch, and, especially in view of the fact that, as will be shown hereinbelow, gases are introduced into the coil 18 for polymerization, it may be considerably higher, for example 1000 to 2000 pounds or more, the upper limit depending primarily upon the strength of available apparatus and the balance of economy between the increased value of the products obtained by polymerization under high pressures as against the cost of pumping gas and liquid through the coil 18 under such high pressures.

The heated products from the coil 18 pass through a transfer line 19 wherein is located a pressure-reducing valve 20 into the evaporator 3, which is preferably maintained at a reduced pressure, for example 100 to 200 pounds per square inch, although, as is well known in the art, the pressures carried in such evaporators may vary from a few pounds to several hundred pounds, being limited in this respect only by the necessity of carrying a lower pressure than obtains in any of the heating coils discharging thereinto.

Residual products or tar which remain unvaporized in the evaporator 3 and collect in liquid form in the bottom thereof are withdrawn through a valved line 21, while the liberated vapors pass upward through the trap-out tray 15 into the primary fractionator 4 where they are further fractionated to some extent and serve to distill the fresh charging stock introduced through the line 13. The remaining vapors, consisting largely of gas oil and naphtha together with fixed gases, pass by way of a line 22 to the lower part of the secondary fractionator 5, the interior of which is provided with the usual plates or trays 23, and wherein these vapors are fractionated to condense and separate distillate heavier than gasoline, i. e. gas oil. The gas oil condensate, which constitutes a clean charging stock suitable for cracking at high temperatures, is withdrawn from the bottom of the secondary fractionator 5 through a line 24 having a valve 25 and a pump 26, and passes by way of line 24 to a pipe coil 27 located in the furnace 1.

As the oil passes through the coil 27 in the furnace 1 it is heated to a relatively high cracking temperature, preferably under so-called vapor-phase conditions, for example at a temperature of from 850° to 1000° F. and preferably above 900° F., under a pressure of from a few pounds per square inch to several hundred pounds per square inch, preferably somewhat higher than the pressure maintained in the evaporator 3.

The highly heated cracked products then pass by way of a transfer line 28 wherein is located a pressure-reducing valve 29 into the evaporator 3, and the vapors pass upward through the primary fractionator 4 and into the secondary fractionator 5, while tar or residual oil is withdrawn at 21 in the manner indicated hereinabove.

The overhead vapors from the secondary fractionator 5 pass by way of a vapor line 30 to a condenser 31 and a gas separator 32 from which gasoline formed in the system may be withdrawn through a line 33 having a valve 34, while gases formed in the process pass by way of a line 35 in which may be located a pump or compressor 36 to the absorber 7 of the gas-fractionating system 6.

The purpose of the gas-fractionating system 6, as has been indicated hereinabove, is to effect a separation of the gas into two fractions, one comprising largely hydrogen and methane which are unsuitable for polymerization, and the other fraction being relatively concentrated with respect to gaseous olefins. Various gas-fractionating systems for this purpose are known in the art, and the details of such a system neither form a part of my invention in themselves nor require lengthy description here. However, the drawings illustrate the principal features of one particular type of gas-fractionating apparatus, in which the gases passing through the scrubber 7 are scrubbed with a suitable solvent such as liquid butane having selective properties with respect to gaseous olefins as distinguished from hydrogen and methane, such solvent being introduced to the scrubber 7 by means of a line 37.

The scrubbed gases, comprising largely hydrogen and methane, or at any rate more highly concentrated in these constituents, escape from the

scrubber 7 through a valved line 38, while the enriched solvent passes through a line 39 wherein are located a pump 40 and a heat-exchanger 41 to the stripper 8, which is shown as provided with a conventional heating coil 42, dephlegmating coil 43 and suitable plates or trays 44. In the stripper 8 the absorbed gases, comparatively rich in gaseous olefins as compared to the gases entering the scrubber 7, are driven off from the solvent, the stripped solvent being returned by means of a pump 45 located in the line 37 and by way of the heat-exchanger 41 and a cooling coil 46 to the scrubber 7. The concentrated olefinic gases pass out of the stripper 8 through a line 48 and are delivered by means of a pump 49 and a branch line 50 having a valve 51 to the inlet of the coil 18. Alternatively, all or a portion of the gases thus returned may be delivered by means of manifold connections 52 having valves 53 to various spaced points along the coil 18, the introduction of the gases to the coil 18 being regulated by means of the valves 53 to provide a gradual introduction of such gases to the oil traversing the coil 18 and to make it possible to closely regulate the action taking place in the coil 18.

Additional gas oil or clean charging stock from an outside source may be introduced to the vapor-phase cracking coil 27 by means of a line 54 having a pump 55 and a valve 56 and communicating with the line 24 and, as is pointed out elsewhere in the specification, such gas oil may be drawn from the same stripping operation which is employed to produce heavier oil to be charged to the coil 18.

Similarly, additional gases containing olefinic constituents may be introduced into the system as desired, the point of introduction depending upon the olefin concentration of such gases. For example gases containing say 30% or more of gaseous olefins and which do not require further fractionation for concentration thereof may be introduced by means of a line 57 having a valve 58 and which communicates with the line 48. Less highly concentrated olefinic gases or, if desired, olefinic gases of any degree of concentration short of that obtainable in the gas-fractionating system 6, may be introduced to the line 35 through a line 59 having a valve 60, these gases being commingled with gases from the separator 32.

As will be made more clear hereinbelow, virgin naphtha from an outside source, for example from the same crude stripping operation which is employed to produce a charging oil for the various operations of the combination unit which have been described hereinabove, may be subjected to cracking in a separate coil for the purpose of reforming the same and increasing its anti-knock content, and the heated products from the reforming operation may be introduced into the evaporator 3, the reformed gasoline in this instance being collected along with the polymerized gasoline and the cracked gasoline withdrawn from the separator 32.

The instance which has been described hereinabove will serve to illustrate my process as carried out in conjunction with a combination-unit oil-cracking operation in which the products from the high-temperature or vapor-phase cracking coil and from the low-temperature or viscosity-breaking coil discharge into a single evaporator. In Fig. 2, however, I have illustrated an operation in which the products from these coils discharge into separate evaporators, which are in turn connected to separate fractionating systems, and I have further illustrated a preferred manner of combining a unit of this character with a crude stripping operation and a gas-cracking operation as well as a naphtha-reforming operation.

In the instance shown in Fig. 2, the products from the coil 18 pass to the evaporator 3 and vapors from the latter pass through the primary and secondary fractionators 4 and 5 as in the instance illustrated in Fig. 1. However, in this instance, a separate evaporator 3' and fractionator 5' are provided for the products from the vapor-phase cracking coil 27. There is also provided a furnace 70 having associated therewith an evaporator 71 and a fractionator 72, and there are also provided a gas-cracking furnace 73 and a reforming furnace 74. In this modification, the operation may be as follows:

Crude petroleum is introduced by means of the pump 11, passing through a heat-exchange coil 12' located in the upper portion of the fractionator 5' and thence through a line 75 to a heating coil 76 located in the furnace 70, and wherein the stock is heated to a temperature short of cracking but sufficient to provide enough heat for the vaporization of volatile constituents of the petroleum, and preferably under a moderately elevated superatmospheric temperature. The pre-heated crude petroleum then passes by way of a line 77 having a reducing valve 78 into an evaporator 71 where a volatilization of the lighter constituents of the petroleum occurs, vapors passing upward through a trap-out tray 79 into the fractionator 72 while the residue or reduced crude is withdrawn from the evaporator 71 and passes through a line 80 having a valve 81 and a pump 82 to the primary fractionator 4 for further distillation. Residual components from this distillation pass through the line 16 to the coil 18 as in the instance illustrated in Fig. 1.

The fractionator 72 is operated to condense constituents heavier than naphtha, that is to say, virgin gas oil, which is withdrawn from the trap-out tray 79 through a line 83 wherein is located a pump 84 and passes through the line 83 and the line 24 to the vapor-phase cracking coil 27. The highly heated products from the coil 27 pass through the transfer line 28 into the evaporator 3' from which heavy or tarry products may be withdrawn through a line 84 and either discarded through a valved branch line 85 or passed through a line 86 having a valve 87 to the evaporator 3. In the event that the tarry products from evaporator 3' are passed to the evaporator 3, in the manner indicated, then it is preferable to maintain evaporator 3 under a materially lower pressure than that maintained in evaporator 3'. For example, a pressure of from 25 to 50 pounds may be maintained in 3 while a pressure of about 200 pounds is maintained in 3'. As a further alternative, tar withdrawn from the evaporator 3' may be delivered to a separate tar flasher (not shown) from which cracked tar is separately withdrawn, while liberated vapors pass to the evaporator 3.

Vapors from the evaporator 3' pass through a line 22' to the fractionator 5' wherein they are fractionated to condense constituents heavier than gasoline, i. e. gas oil, which may be withdrawn through a line 88 having a valve 89 and a pump 90 and communicating with the line 24 and recycled to the coil 27. If desired, any desired portion of the gas oil collected in the fractionator 5' may, however, be withdrawn from the system through a valved branch line 91.

Overhead vapors from the fractionator 5' pass

through a line 30' to a condenser 31' and a separator 32', gases from which are caused to pass through a line 35' and the line 35 under the influence of the compressor 36 into the absorber 7 of the gas-fractionating system 6, the gases from the gas-fractionating system 6 being returned by way of line 48 to the coil 18, as in the instance illustrated in Fig. 1. Condensate is withdrawn from the separator 32' through a line 92 having a valve 93, and in the preferred instance illustrated passes to a blending tank 94, although it may be separately withdrawn from the system if desired.

In this instance, the gases from the separator 32, comprising the incondensable portions of products withdrawn from the top of the secondary fractionator 5, may be withdrawn from the system through a valved conduit 95, or may pass by way of the line 35 which is provided with a valve 96 to the gas-fractionating system 6, or may be cracked as described hereinbelow.

Overhead vapors from the fractionating tower 72 of the crude distillation unit pass through a line 100 to a condenser 101 and a separator 102, from which virgin naphtha of relatively low anti-knock value is withdrawn through a line 103 having a valve 104 and a pump 105 into a reforming or cracking coil 106 located in the furnace 74 wherein the naphtha is heated to a relatively high cracking temperature effective to increase the anti-knock value of the naphtha without greatly modifying its boiling-point characteristics. Suitable temperatures for this operation are from 950° to 1050° F., preferably about 1000° F., and the heating is preferably conducted under a pressure in excess of 200 pounds, for example 1000 pounds or higher. The hot reformed products issue from the reforming coil 106 through a transfer line 107 and may pass either by way of a branch line 108 having a valve 109 into the evaporator 3 of the viscosity-breaking unit, or they may pass by way of a line 110 having a valve 111 into the evaporator 3' of the vapor-phase cracking unit.

Where the vapors pass to the evaporator 3 of the viscosity-breaking unit, the gasoline withdrawn from the separator 32 through the line 33 and which may be delivered, if desired, to the blending tank 94, will be of good antiknock value, and the gases removed from the separator 32 will ordinarily be sufficiently concentrated in gaseous olefins to warrant their introduction by way of the line 35 into the gas-fractionating system 6. Where, however, the reformed products are discharged by way of the line 110 into the evaporator 3' of the vapor-phase cracking unit, the gases issuing from the separator 32 may, if desired, be removed from the system through the line 95 and the gasoline or naphtha in the separator 32 may similarly be removed from the system or may be passed to the reforming coil 106 for further conversion.

Gases liberated in the crude distillation stage and separated from condensate in the separator 102 may, if desired, be withdrawn from the system, but in the preferred instance these gases pass through a line 120 having a valve 121 and, if necessary, a pump 122, to a gas-cracking coil 123 located in the furnace 73 wherein these gases are heated to a temperature of from 1250 to 1750° F. under a pressure preferably not in excess of 200 pounds per square inch to effect a conversion or cracking of gaseous paraffins to gaseous olefins suitable for polymerization. The hot cracked gases are then cooled, as, for example, in a condenser 124, and after separation of any liquid products of cracking, which separation takes place in a separator 125 having a liquid off-take 126, the cracked gases pass through a line 127 having a valve 128 and a pump or compressor 129 and by way of the line 35 to the absorber 7 of the gas-fractionating system 6.

Referring to Fig. 2, when products from the naphtha-reforming coil 106 are passed by way of the line 108 into the evaporator 3, gases from the separator 32 are preferably delivered to the scrubber 7 by reason of their relatively high content of gaseous olefins. Where, however, products from the naphtha-reforming coil 106, together with products from the vapor-phase cracking coil 27, discharge into the evaporator 3', and the evaporator at 3 receives only the products from the coil 18, the gases liberated from the separator 32 will not contain unsaturates in as high a concentration, and in this instance these gases are preferably delivered by way of a line 130, wherein are located a valve 131 and a pump 132, to the line 120 to be introduced into the gas-cracking coil 123. The cracked gases from coil 123 may then be returned by way of lines 127 and 35 to the scrubber 7 for concentration as described.

As has been indicated hereinabove, a crude distillation unit, a gas-cracking unit and a naphtha-reforming unit as illustrated in Fig. 2, or any of these, may be combined with a combination unit of the type illustrated in Fig. 1, thus the charge introduced at 10 in Fig. 1 may comprise reduced crude withdrawn from an evaporator such as that illustrated in 71 in Fig. 2. Again, virgin gas oil such as that withdrawn at 83 in Fig. 2 may be introduced into the vapor-phase cracking coil 27 of Fig. 1, and the evaporator 3 of Fig. 1 may receive gas from a reforming coil such as that illustrated at 106 in Fig. 2, and which may in turn receive virgin naphtha from a source such as the separator 102 of Fig. 2. Furthermore, gases from a crude distillation unit such, for example, as those removed from the separator 102 of Fig. 2 may be introduced at 59 or 57 in the instance illustrated in Fig. 1 with or without cracking in a coil such as that illustrated at 123 in Fig. 2.

It will be seen from the above that my invention provides for a polymerization of gases containing olefinic constituents as an adjunct to and a part of a cracking system of the so-called "combination-unit" type as defined hereinabove, wherein polymerization of the gases is effected in such manner as to avoid the necessity for separate polymerizing equipment and without interference to the various oil-cracking operations carried out in the unit as a whole. The process of my invention has a further advantage in that it permits desirable cross-reactions to take place between the heavy oil undergoing cracking and the gas undergoing polymerization in the coil 18 and the recovery of the products in a simple and efficacious manner.

While I have described my invention hereinabove with respect to various specific operating conditions and with reference to various typical oil-cracking operations of the combination-unit type and have in the drawings illustrated various types of apparatus for this purpose, it will be understood by those skilled in the art that my invention is not limited to such specific operative or illustrative details except insofar

as such limitations are embodied in the claims hereinafter made.

I claim:

1. In a process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel in which a heavy hydrocarbon oil containing residual constituents is subjected to a mild cracking temperature under a high superatmospheric pressure, the products are fractionated to recover a clean condensate, said condensate is separately subjected to more drastic cracking conditions and the products are fractionated to separate gases, naphtha and heavier distillate, the improvements which comprise fractionating said gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with the heavy hydrocarbon oil for subjection to said mild cracking temperature and said high superatmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

2. In a process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel in which a heavy hydrocarbon oil containing residual constituents is subjected to a mild cracking temperature of from 800° to 900° F. under a pressure in excess of 500 pounds per square inch, the products are fractionated to recover a clean condensate, said condensate is separately subjected to a cracking temperature in excess of 900° F., and the products are fractionated to separate gases, naphtha and heavier distillate, the improvements which comprise fractionating said gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with the heavy hydrocarbon oil for subjection to said temperature of from 800° to 900° F. and said pressure in excess of 500 pounds per square inch to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

3. In a process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel in which a heavy hydrocarbon oil containing residual constituents is subjected in a first cracking stage to a mild cracking temperature under a high superatmospheric pressure, a clean condensate is subjected in a second cracking stage to more drastic cracking conditions, the products from said first and second cracking stages being delivered to a common evaporator and the vaporous products from said evaporator being fractionated to separate gases, naphtha and heavier condensate, the improvements which comprise fractionating said gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with the heavy hydrocarbon oil for subjection to said mild cracking temperature and said high superatmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

4. In a process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel in which a heavy hydrocarbon oil containing residual constituents is subjected in a first cracking stage to a mild cracking temperature under a high superatmospheric pressure, the products are fractionated to recover a clean condensate, said condensate is separately subjected in a second cracking stage to more drastic cracking conditions and the products are separately fractionated to separate gases, naphtha and heavier distillate, the improvements which comprise fractionating said gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with the heavy hydrocarbon oil for subjection to said mild cracking temperature and said high superatmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

5. In a process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel in which a heavy hydrocarbon oil containing residual constituents is subjected in a first cracking stage to a mild cracking temperature under a high superatmospheric pressure, the products are fractionated to recover a clean condensate, naphtha and gases, said condensate is separately subjected in a second cracking stage to more drastic cracking conditions and the products are fractionated to separate gases, naphtha and heavier distillate, the improvements which comprise fractionating gases from said first and second cracking stages to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with the heavy hydrocarbon oil for subjection to said mild cracking temperature and said high superatmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

6. A process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel which comprises distilling a crude petroleum to separate it into gas, naphtha, gas oil and residual constituents, subjecting said residual constituents to a mild cracking temperature under a high superatmospheric pressure, fractionating the products to recover naphtha and heavier clean condensate, commingling said gas oil and said clean condensate, separately subjecting them to more drastic cracking conditions and fractionating the products to separate cracked gases and distillate, fractionating said cracked gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with said residual constituents for subjection to said mild cracking temperature and said high super-atmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

7. A process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel which comprises distilling a crude petroleum to separate it into gas, virgin naphtha, gas oil and residual constituents, subjecting said residual constituents to a mild cracking temperature under a high superatmospheric pressure, separately subjecting said virgin naphtha to a cracking temperature to effect a reformation thereof to naphtha of higher anti-knock value and fractionating the reformed products in the presence of the products of said mild

cracking operation to recover naphtha and heavier clean condensate, commingling said gas oil and said clean condensate, separately subjecting them to more drastic cracking conditions, and fractionating the products to separate cracked gases and distillate, fractionating said cracked gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with said residual constituents for subjection to said mild cracking temperature and said high super-atmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

8. A process for converting hydrocarbon oil into relatively low-boiling hydrocarbon oil suitable for use as motor fuel which comprises distilling a crude petroleum to separate it into virgin gas, naphtha, gas oil and residual constituents, subjecting said residual constituents to a mild cracking temperature under a high superatmospheric pressure, fractionating the products to recover naphtha and heavier clean condensate, commingling said gas oil and said clean condensate, separately subjecting them to more drastic cracking conditions, and fractionating the products to separate incondensable gases and distillate, cracking said virgin gas to increase the olefin content thereof, commingling the thereby cracked gas with said incondensable gases, fractionating the commingled gases to separate them into a lean fraction comprising principally hydrogen and methane and a rich fraction containing a relatively large amount of gaseous olefins, and commingling said rich fraction with said residual constituents for subjection to said mild cracking temperature and said high super-atmospheric pressure to effect a polymerization of gaseous olefins contained in said rich fraction to normally liquid products.

PIKE H. SULLIVAN.

DISCLAIMER

2,017,874.—*Pike H. Sullivan,* New Rochelle, N. Y. TREATMENT OF HYDROCARBONS. Patent dated October 22, 1935. Disclaimer filed September 18, 1937, by the assignee, *Gasoline Products Company, Inc.*

Hereby enters this disclaimer to claims 1, 3, and 5 of the aforesaid Letters Patent.

[*Official Gazette October 12, 1937.*]