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METHOD AND APPARATUS FOR TREATING A PLURALITY OF HEAVY
HYDROCARBON OILS FOR SUBSEQUENT CRACKING
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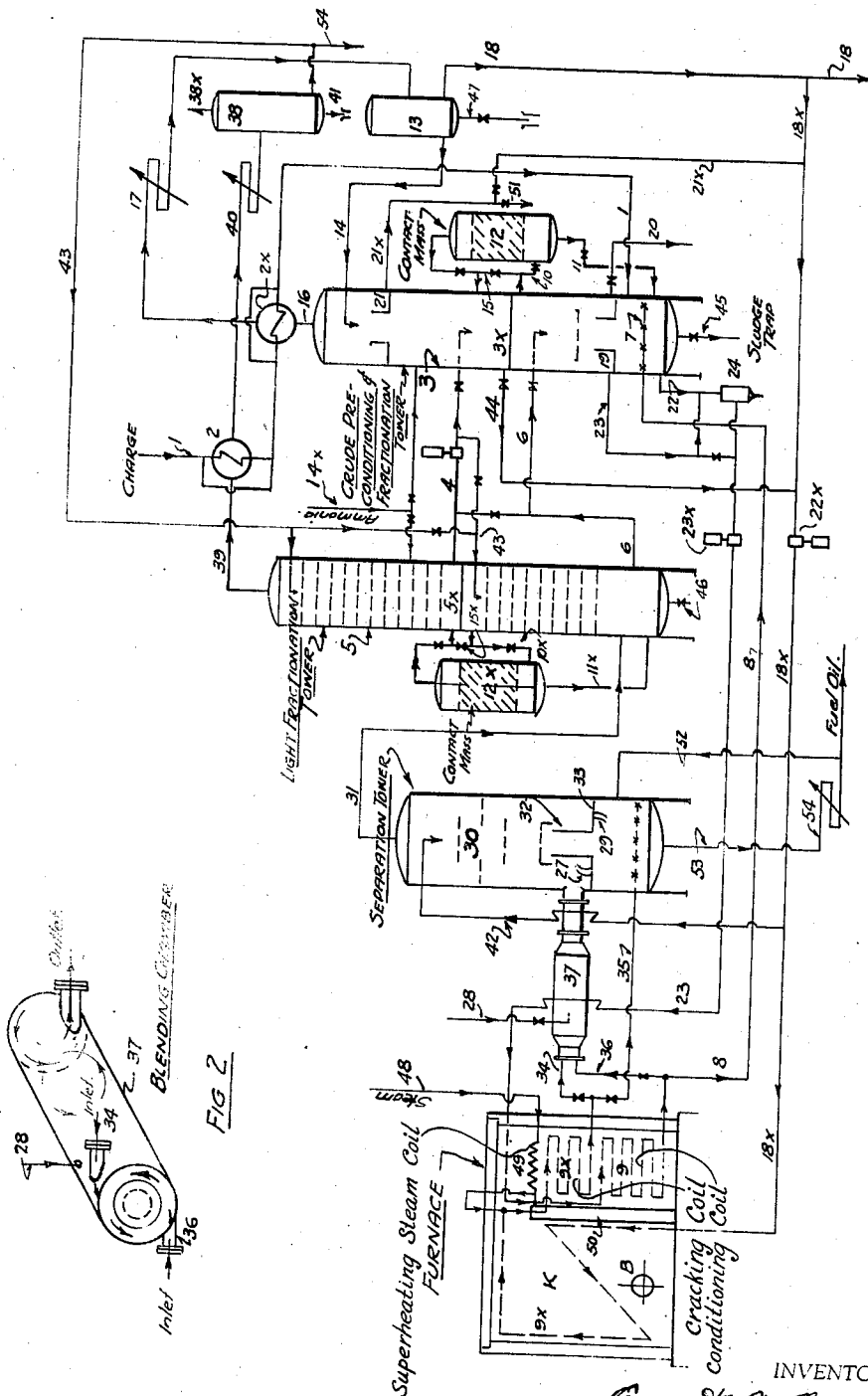


FIG. 1.

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METHOD AND APPARATUS FOR TREATING A
PLURALITY OF HEAVY HYDROCARBON
OILS FOR SUBSEQUENT CRACKING

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Application February 7, 1938, Serial No. 189,136

10 Claims. (Cl. 196—48)

This application is a continuation in part of my application Serial No. 67,199, filed March 5, 1936, now Patent No. 2,130,596, granted September 20, 1938.

5 The object of the invention is to provide a novel method and apparatus for treating hydrocarbon materials such as petroleum oils preliminary to cracking, characterized by the preliminary common vaporization treatment, with
10 the aid of hot gases, vapors, or both, in a pre-conditioning and selective fractionating tower, of materials having different characteristics, as (a) an initial uncracked hydrocarbon oil charging stock, such as crude petroleum oil, and/or a
15 topped crude oil, liquefied coal products, ground coal or coke mixed with liquid hydrocarbons as a carrier, shale oil, and the like, (b) insufficiently converted hydrocarbons, such as an intermediate reflux condensate, substantially free from tarry material formed from vapors of cracking,
20 and (c) products from a mild heat or splitting treatment for conditioning or reconditioning heavy oils containing refractory materials, such as heavy ends of reduced crude oil and heavy
25 reflux condensate of converted products, for higher temperature cracking. This preliminary treatment is carried out to form from the vaporized and unvaporized blended fractions at least two preconditioned or purified streams of material having different characteristics and boiling
30 ranges, each stream being adapted for separate treatment under conditions selectively controlled for subsequent conversion. Thus, two streams may be led to different heating zones and subjected to different thermal treatments for a
35 maximum conversion of the materials into high anti-knock motor fuels with a minimum formation of gas and coke.

In promoting this main object of preconditioning a plurality of materials to obtain an optimum yield of desired products, this invention also provides for economies realized through novel features of using hot conversion products as distillation aids and in the efficient removal
45 of deleterious substances from the conversion products. These objects and the manner and means for accomplishing them will become apparent from the description which follows.

For example, in the preliminary vaporization treatment for the formation of two or more preconditioned streams of hydrocarbon oils having different characteristics and boiling ranges there are passed at least two streams
50 of hydrocarbons, to wit: a regulated stream of uncracked initial oil, e. g. crude oil, which is

preferably preheated to below a cracking temperature, and a regulated stream of oil containing products from a previously cracked oil. Vapors from these materials are blended and increased in temperature by an added blast of
5 vapors, preferably a blast of hot hydrocarbon products from a moderate splitting of heavy hydrocarbons at low cracking temperatures in the presence of a hydrogenous gas, e. g., steam, and having a temperature of about 800° F.,
10 which blast serves a threefold purpose: (1) to increase the fluidity of materials injected into the tower; (2) to increase the vaporization of volatiles in the injected materials so as to release therefrom more lower boiling fractions
15 without cracking; (3) to obtain a conservation of heat energy.

Connected with the said preliminary, pre-conditioning tower may be provided purifying contact mass which is capable of removing
20 sulfurous impurities, tar and coke forming impurities, etc. This contact mass may contain desulfurizing agent such as metals or metal compounds of the desulfurizing type over which vapors passing to the upper part of said tower
25 for fractionating may pass. The metals or compounds may advantageously be mixed or bound with adsorbents such as Florida earth, attapalugus clay, fuller's earth, bentonite, bauxite, and the like. The desulfurizing agent
30 may also be in granular form or on the surface of an inorganic carrier, e. g., granules of Portland cement, fibrous asbestos or similar materials.

In the preliminary tower or preconditioning
35 and fractionating zone at least two bodies of oil preconditioned for further processing are formed, one of gas oil type with substantially virgin gas oil quality for high temperature cracking to produce high anti-knock motor fuel
40 with a minimum of coke formation and another for obtaining lubricating oil or for further conditioning to obtain more virgin quality cracking stock by moderate heat treatment at low
45 cracking temperature. In leading a stream from each of these bodies to separately controlled heating zones for conversion under different thermal conditions, conversion products from both zones can be blended and further purified, if desired, and the blended vapors
50 are subjected to common fractionation and condensation.

The pressure employed in the preliminary tower is preferably low compared with other parts of the system, e. g. subatmospheric, especially in
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forming lubricating oil stocks, atmospheric, or less than about 10 atmospheres.

In brief, the vapor blend of cracked and uncracked hydrocarbons, comprising constituents of straight run and cracked character formed in the preliminary tower is purified and fractionated to obtain at least a highly desirable gas oil type cracking stock of lower sulphur content. A reforming stock can be condensed from the overhead following the condensation of the gas oil type fraction. The purified gas oil type cracking stock formed in the preliminary tower may be led to a cracking zone to be cracked at about 900 to 1100° F., at a superatmospheric pressure, or be blended with more recycle stock for cracking at about the same pressure and temperature conditions. Heavier fractions and unvaporized oil formed in the preliminary tower make up materials which can be used to refine into lubricants or be led to the separately controlled moderate heating zone to obtain more conditioned products for blending with the gas oil type fraction before or after the high temperature cracking of said gas oil type fraction. This moderate heating treatment of oils higher boiling than gas oil is carried out at about 700 to 850° F., under pressure, with lowered temperatures if a catalyzing contact mass is used, and preferably with the aid of a hydrogenous gaseous agent, e. g. steam, to obtain mainly a moderate splitting of its constituents.

In addition, this invention contains improvements in enhancing the virgin qualities of distillates to be condensed from vapors containing partially converted recycle stock and straight run cracking stock constituents and for enhancing the yields of such vapors for obtaining increased yields of purified fractions for high temperature cracking with a minimum coke formation. In particular, attachments to the fractionating towers give this improved purification and a novel use of high temperature cracking products in forcing vaporization of more moderately cracked oils with increased stripping of volatiles to enhance the yields.

The process will be described in conjunction with the accompanying drawing in which

Fig. 1 is a diagrammatic representation of apparatus for effecting one embodiment of the process, and Fig. 2, is an isometric drawing of the blending chamber.

Referring to the drawing, Fig. 1, the charging stock, for example, a crude oil, flows through pipe 1 through heat exchanger 2, and similar heat exchanger 2x, to be thereby heated to a temperature of about 400 to 700° F. The charging stock thus preheated is flashed into the bottom part of the lower section of the preliminary tower 3 for preconditioning and fractionating. Simultaneously, there is passed into said tower 3, by valved lines 6 and/or 4 and 6 hot reflux condensates from tower 5, these condensates having a temperature in the range of about 400 to 700° F., and containing insufficiently converted products higher boiling than gasoline. A lighter and purer fraction led from above a partition 5x in tower 5 by line 4 is preferably led into tower 3 above partition 3x. These condensates in passing from the tower 5, generally having a higher pressure, into the lower pressure zone in tower 3 will flash into tower 3 with a substantial liberation of vapors. The unvaporized portions of the hot condensates from tower 5 and from the crude oil pass by gravity countercurrent in direction to vapors in tower 3; these vapors including, be-

sides the volatiles from the flashed condensates and crude oil, gaseous products from the blast of materials injected through jets 7, connected by pipe 8, with a heating coil 9, in the convection section of furnace K, which coil is termed the conditioning and reconditioning coil and in which the heaviest fractions formed in tower 3, are heated to low cracking temperatures. By this means, hot products from coil 9, hot reflux condensate products from tower 5, and preheated crude oil components are mixed and jointly vaporized in the crude vaporizing section of tower 3, the degree of vaporization being increased with a conservation of heat energy, the fluidity of the bodies being increased, and a vapor blend being produced under conditions conducive to ready purification and formation of a high quality cracking stock distillate. If desired, vapors from the crude oil vaporizing section of tower 3, below partition 3x, may be passed to the fractionation section above partition 3x, through a purifying agent 12, via valved pipe 10, for sulphurous and tar forming material removal, 15 being a by-pass for the vapor if purification is not necessary, and a refluxing and cooling agent may be injected in the fractionating section by line 14, from any suitable source, for example, tank 13 such as shown, and ammonia by valved line 14x. Light gasoline constituent vapors pass upwardly in tower 3, to be led overhead by pipe 16, to condenser 17, thence to receiver 13. Part of the condensate in receiver 13, can be led by line 18, to storage or be passed by line 18x, to join materials undergoing high temperature cracking in the section of the multi-coil system in furnace K, receiving the most heat, e. g. coil 9x. Water from receiver 13 is withdrawn by line 47. A stream of heavy naphtha fraction from pan 21, may be added by line 21x, to the gasoline stream passed by line 18x to coil 9x, or may entirely replace said gasoline stream in 18x, or may be sent to storage by line 51.

A preconditioned and purified distillate of about gas oil boiling range with substantially virgin gas oil quality formed above partition 3x, disposed within tower 3, is drawn off to be passed by valved line 44, and pump 22x, to the high temperature cracking coil 9x, wherein such oil is heated preferably under a superatmospheric pressure of about from 5 to 50 atmospheres and to an anti-knock gasoline forming cracking temperature of about 900 to 1100° F., for a period to obtain substantial conversion of the oil treated into gasoline hydrocarbons.

Preconditioned residual fractions higher boiling than gas oil collected as unvaporized oil at the bottom of tower 3, and at pan, 19, as heavy distillate, below partition 3x, are withdrawn to be used as lubricating oil stock or further conditioned. For further conditioning, such residual oils are passed by line 22 and 23, by pump 23x, and through a sludge trap 24, if necessary for removal of sedimentary sludge, to the more moderately heated coil 9, to be heated to low cracking temperatures of about 700 to 850° F., under a low pressure and less than that applied to coil 9x and exceeding the pressure in towers 30, and 3, and for a time to obtain only a small amount of splitting of the hydrocarbons. Heavy distillate collected in pan 19 below partition 3x of the tower 3 may be withdrawn separately as lubricant stock is desired. Water or steam from any suitable source is passed through pipe 48, into superheating steam coil 49, then, as superheated steam passes into the moderately heated coil 9, 75

in which said residuals oil fractions are treated. The steam may be superheated in coil 49, with reducing gases such as natural gas, fixed gas from the cracking process etc.

5 The heating coils 9, 9x, and 49, are disposed in furnace K, having a burner B. This furnace is represented as being of a type which has a bridge wall 50, forming a radiant heat section in which coil 9x, is mainly located. Leaving coil 9, the
10 products of the moderate thermal treatment are preferably divided into two controlled streams under regulated pressure, one of these streams may pass through pipe 36, into a blending zone 37, wherein such products are blended with
15 cracked products from coil 9x, passed into this blending zone through pipe 34, the discharge of materials into this zone being under expansion. The other stream passes through pipe 8, and discharges with expansion into the lower part of
20 tower 3, through spray 7.

Fig. 2 illustrates by isometric drawing the method in which the low temperature split products of coil 9 of the furnace are forced into circulation under great turbulence by the high velocity of the products from coil 9x that have been
25 cracked under pressure and temperature cracking conditions higher than the said products of coil 9, and which are passed into the blending chamber tangentially through pipe 34 to provide perfect mixing, circulating and turbulent movement with improved conditioning of both products. Provision can be made for the addition of sulfur absorbent agents in a fluid form to blending zone 37, as by pipe 28 and the turbulent action within said zone results in more effective
30 desulfurizing interface contact. The pressure employed in the blending zone 37, and the following separating tower 30, will be less than the pressure in the heating coils 9, and 9x, but preferably greater than the pressure in tower 3.

Leaving the convection heated section of coil 9x, the cracked products are passed entirely by line 35 into the lower part of separator 30, or partly thereto and partly by pipe 34, into the
45 blending zone 37. Chamber 37, discharges into the vapor separating tower 30, which is specially equipped at its midsection with a means 33, and 32, designed for retaining a pool of liquids in heated condition and in a state of high circulatory motion and turbulence induced largely by vapors and gases arising by upcomers 27, from the lower part of tower 30, the circulation being
50 guided by the walls of the vessel 30, and cylindrical projection 32. Residual liquids retained by means 33, tend to drop down outlets such as downcomer pipes 29, indicated, and to pass counter-current to rising hot vapors in the lower part of tower 30, where they are subjected to a further stripping action, and finally the stripped
55 residues collect in a lower pool of liquids, which is cooled by the injected cool fuel oil, through line 52 which may be a portion of the residual withdrawn by line 53, through cooler 54. This novel arrangement serves to increase greatly the yield of vapors to be passed from separator 30, to fractionator 5, by pipe 31. Hot gas oil from line 18x, passed by line 42, into the upper part of
60 tower 30, aids in knocking down tar and developing a blend of vapors of cracked and uncracked hydrocarbons.

Vapors from the separation zone of tower 30, pass overhead by line 31, to enter the lower part of lower section of tower 5, in which the vapors may be made to pass through conventional trays,
70 or the like, and relatively cool refluxing oil, for

example, a gasoline condensate passed by pipe 43, from receiver 38, to condense out a heavy gas oil fraction. Light hydrocarbons remaining in the vapor phase including gasoline, in the lower part of tower 5, may be passed to the upper part
5 of said tower 5, for further fractionation, by valved line 10x, through an adsorptive contact mass 12x, which may be similar in composition and function to purifying contact mass 12, previously described, especially if contact mass 12, 10 is not used, 15x being a by-pass for the vapors if purification is not necessary. In the upper part of tower 5, above partition 5x, the vapors led thereto from below partition 5x, are further
15 fractionated to form a reflux condensate of higher boiling range than gasoline, permitting uncondensed vapors containing gasoline hydrocarbons to pass overhead through line 39, to condenser 40, whence uncondensed gaseous material and condensate pass to receiver tank 38, in which the
20 gasoline is subsequently separated from the fixed gases and any water condensate, line 38x being gas outlet, line 54, to withdraw gasoline from the system, and line 41, for withdrawing water condensate. Some of the gasoline condensate
25 may be run back by pipe 43, into the upper and lower parts of tower 5, to act as a refluxing agent. Ammonia from any suitable source may be passed also to the upper part of tower 5 by valved line 14x.

Hydrogenous gas composed of compounds containing or yielding hydrogen under cracking conditions, e. g., steam, may be passed through superheating coil 49, into either or both of the heating coils 9, and 9x, for their beneficial effect
30 of lowering coke formation and moderating the cracking, this being specially useful in coil 9x.

When lubricating oil is desired, lubricating oil stock may be withdrawn from a lower pan such as 19, through line 20 or from a lower part of
40 tower 5, to be further refined. To obtain a lubricating oil stock it is desirable not to introduce high temperature cracking products from tower 5 into tower 3, below partition 3x, or to reduce the quantity of such products thus introduced.

Any solid materials, heavy tar, or sludge that may drop to the base of towers 3, 5, or 30, is preferably drained from the system by valved lines 45, 46, and 53, respectively. A sediment
50 trap 24, may be provided in line 23, for further removal of such materials.

The preconditioning and fractionating tower 3, was conceived with the idea of forming from a plurality of stocks including initial uncracked charging stock, increased quantities of cracking
55 stock which can contain recycle stock in such a purified condition as to be close to virgin oil quality for high temperature cracking without an appreciable amount of coke formation. Tower 5, and its appurtenances provides a means for obtaining a high quality composite reflux fraction or a high quality and purified composite reflux fraction containing recycle stock which form the stream containing insufficiently converted products higher boiling than gasoline passed into the preconditioning and selective fractionating tower
60 3. Tower 30, is equipped to obtain and increase stripping of converted products. Coil 9, provides for the moderate splitting of heavy fraction of the charge oil and of reflux containing heavy recycle stock to condition or recondition such oils into oils which are better suited for high temperature cracking.

The purifying vessels 12, and 12x, attached to towers 3 and 5, respectively, contain purifying
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contact masses of adsorptive and/or absorptive activity in removing impurities such as entrained tarry bodies, tar and gum forming bodies, and sulfurous impurities. Such masses may contain sulfur combining metals or metal oxides, e. g. metals of the iron group, and metals of the second group of the Periodic system and such materials combined with clays or adsorbent earths as previously explained. Several of such vessels can be connected in parallel with each fractionating tower to provide for alternate use of the vessels while one or others are disconnected from the hydrocarbons vapor stream for regeneration by regenerative agents, such as oxidizing gas, etc. By-passes 15 and 15x are provided so that any essential amount of vapors can be purified in either of these purification zones. The contact mass also may be maintained in an active condition for a prolonged period by the presence of controlled small amounts of regenerative agents, e. g., steam, air, carbon dioxide, oxygen, or oxygen compounds, etc., mixed with the hydrocarbon vapor passed through the contact mass.

The size of the furnace, sizes of coils, vessels, and conditions, depend upon the capacity of the unit plant to be operated and upon the desired yields. It is to be understood that additional heating equipment, cooling equipment, controls, pumps, meters for measuring temperature, pressure, flow and other physical or chemical changes, and other conventional equipment of similar types well known in the art may be used where desirable.

Although the heretofore described method covers in detail a preferred mode of operation, the system may be varied in accordance with my invention and I do not wish to limit the apparatus and operation described.

Having described my invention, the method and apparatus of carrying it into practice, it is to be understood that modification and changes may be made provided they do not depart from the scope of the invention and the following claims covering the invention.

I claim:

1. A process for producing high yields of anti-knock gasoline motor fuel with negligible coke formation which comprises distilling an initial uncracked hydrocarbon oil charging stock in a preconditioning and primary fractionating zone into which a blast of hot hydrocarbons conversion products is injected to increase greatly the degree of vaporization of said charging stock without causing substantial cracking and in which mixed vapors of the conversion products and vaporized crude uncracked charging stock are filtered through a solid adsorbent contact mass which removes tar and coke forming impurities, then fractionated to form composite tar free condensates higher boiling than gasoline constituents, collecting in a secondary fractionating zone other tar free purified composite condensates including conversion products and having a boiling range like that of the first mentioned condensates, revaporizing in the first mentioned fractionating zone above mentioned condensates collected in the secondary fractionating zone to form an increased blend of the composite tar free purified condensates, heating said blend of composite tar free purified condensates to a high cracking temperature to convert a substantial part of the blended constituents into anti-knock gasoline hydrocarbons, separately heating a portion of heavier residual oils produced in the preconditioning and fractionating

zone to relatively lower cracking temperatures to obtain a moderate splitting conversion of its constituents to more volatile products with negligible coke formation, mixing conversion products from the above mentioned two heat treatments in a blending and separation zone distinct from the preconditioning and fractionating zone, the more highly heated products acting to increase vaporization, passing blended vapors from said separation zone to said secondary fractionating zone wherein above mentioned tar free purified condensates are condensed from the blended vapors after they are filtered through a solid adsorbent contact mass for revaporization in the first mentioned preconditioning and fractionating zone leaving an overhead vapor fraction from which anti-knock gasoline is recovered, and using part of the products from the moderate splitting conversion as said hot conversion products injected into the preconditioning and primary fractionating zone.

2. A process for producing an increased yield of high anti-knock gasoline motor fuel with negligible coke formation, which comprises heating a substantially tar free purified composite distillate higher boiling than gasoline and composed both of converted and uncracked hydrocarbons to high cracking temperatures to convert a substantial part of its constituents into low boiling vapor products including anti-knock gasoline hydrocarbons, separately heating a less volatile oil mainly composed of uncracked hydrocarbons to lower cracking temperatures to obtain a moderate splitting of its constituents into more volatile products with negligible coke formation, passing conversion products from the above mentioned two heat treatments through a blending zone into a vapor separating zone into which vapor products of the high temperature cracking treatment are injected to act as a stripping blast and to impose a circulation on residual liquids from the moderate splitting conversion which are collected in a highly turbulent pool in a midsection of the separation zone for forced vaporization, passing vapors from the separation zone to a fractionating zone where a substantially tar free purified distillate higher boiling than gasoline is condensed, and using a portion of said distillate from said fractionating zone to make up the tar free composite distillate heated to high cracking temperatures.

3. A process in accordance with claim 2, in which said substantially tar free distillate formed in said fractionation zone is condensed from vapors which have been purified by passage through an absorptive solid adsorbent contact mass.

4. A process for converting hydrocarbon oils into relatively low boiling hydrocarbons suitable as motor fuel with negligible coke formation, which comprises distilling hydrocarbon oils including an initial uncracked charging stock in a preconditioning and primary fractionating zone to produce residual oils and purified intermediate condensates higher boiling than gasoline containing cracked and uncracked hydrocarbons substantially free from tar forming and sulphurous impurities, heating a portion of said residual oils at low cracking temperatures to moderately split its constituents into more volatile products with negligible coke formation, commingling such products in heated condition from the thus treated residual oils with the oils undergoing distillation in the preconditioning and primary fractionating zone to increase the vaporization, pass-

ing vapors of the cracked and uncracked hydrocarbons formed in said primary fractionating zone through a solid adsorbent contact mass capable of eliminating tar forming bodies prior to condensation of said intermediate condensates from these vapors, subjecting said intermediate condensates to cracking at temperatures and pressures higher than those imparted to the residuals subjected to moderate splitting to convert a substantial part of the condensates into gasoline hydrocarbons, separating vapor conversion products of the thus treated condensates from less volatile tarry liquid products, fractionally condensing from the thus separated vapor conversion products a substantially tar free condensate in a secondary fractionating zone, passing the tar free condensate thus formed in said secondary fractionating zone into the preconditioning and fractionating zone where said condensate is revaporized by purified vapors passed through said solid adsorbent contact mass to increase the amount of intermediate condensates composed of cracked and uncracked hydrocarbons formed therein.

5. A process in accordance with claim 4, in which the moderate splitting of residual oil at low cracking temperatures is carried out in the presence of a gaseous hydrogenous compound for moderating the splitting and inhibiting coke formation.

6. A process for converting purified hydrocarbon oils into relatively low boiling hydrocarbons suitable as motor fuels which comprises vaporizing in a preconditioning zone hydrocarbon oils including an initial uncracked charging stock to produce vapors and residual oils, flashing substantially tar free hot condensate higher boiling than gasoline collected in fractionating cracked vapor products into said preconditioning zone to increase the amount of vapors, passing mixed vapors of the vaporized initial charging stock and of the flashed condensate through an adsorptive contact mass to remove any entrained tar bodies, tar and coke forming bodies, and sulfur compound impurities, fractionally condensing a purified composite cracking stock higher boiling than gasoline from thus purified mixed vapors, subjecting said purified composite cracking stock to cracking to convert a substantial part of its constituents into gasoline hydrocarbons with negligible coke formation, fractionating vapor products of the cracking to collect additional quantities of the aforementioned substantially tar free hot condensate higher boiling than gasoline for flashing into the preconditioning zone wherein said condensate is distilled in contact with the purified mixed vapors which have passed through the adsorbent contact mass.

7. A process for producing increased yields of high anti-knock gasoline motor fuel with negligible coke formation, which comprises substantially vaporizing an initial uncracked hydrocarbon oil charging stock to form a volatilized fraction higher boiling than gasoline, treating said volatilized fraction with a solid adsorbent capable of removing tar forming impurities from the volatiles in said volatilized fraction, heating an un-

vaporized portion of the charging stock to a low cracking temperature to obtain a moderate splitting of its constituents into more volatile products conditioned for higher temperature cracking, passing products of said moderate splitting into a blending and vapor separating zone whence separated vapors are passed through an adsorptive contact mass for purification and then through a fractionating zone, fractionally condensing in said fractionating zone a purified condensate higher boiling than gasoline, forming a blend of said purified condensate with part of said solid adsorbent treated volatiles from the charging stock of similar boiling range to said purified condensate, heating said blend to a high cracking temperature to convert a substantial part of its constituents into gasoline hydrocarbons, and injecting highly heated products from said converted blend into said separating zone wherein they contact with and increase the vaporization of products of said moderate splitting.

8. Apparatus for treating hydrocarbon oils, which comprises a plurality of means for heating vaporizable liquids of different characteristics at least one of which is a hydrocarbon liquid, means for applying higher heat to one of said heating means, a blending device having an outlet for the removal of the products blended therein comprising intermixed vapors and liquids and having inlet communications from each of said heating means, said blending device having a horizontally elongated cylindrical shape, means for delivering the heated products from both of said heating means tangentially into one end of said blending device, said delivery means and the blending chamber being so formed and correlated as to cause a whirling turbulence of the heated products in the blending device, and an enlarged vapor-liquid separating means into which the thus blended products are totally discharged from the outlet of said blending device.

9. Apparatus for treating hydrocarbon oils conducted in accordance with claim 8 in combination with means for passing a purifying material into said blending chamber during the turbulent movement of the heated hydrocarbon products therethrough.

10. A process for treating hydrocarbon oils which comprises heating a high boiling liquid hydrocarbon oil to an elevated temperature insufficient to completely vaporize said oil and heating a vaporizable liquid to a relatively higher temperature to convert said liquid substantially into vapor products, passing the heated oil products to a blending zone simultaneously with the injection therein of the heated vaporizable-liquid products, at least one of said products passing tangentially within said zone and thereby effecting a whirling turbulence of the zone contents, maintaining vapor phase and liquid phase contents completely mixed by the whirling turbulence in simultaneous and concurrent passage through the blending zone, discharging the turbulent products from the blending zone in one stream to a separating zone, and separating the vapor and liquid constituents thereof.

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