

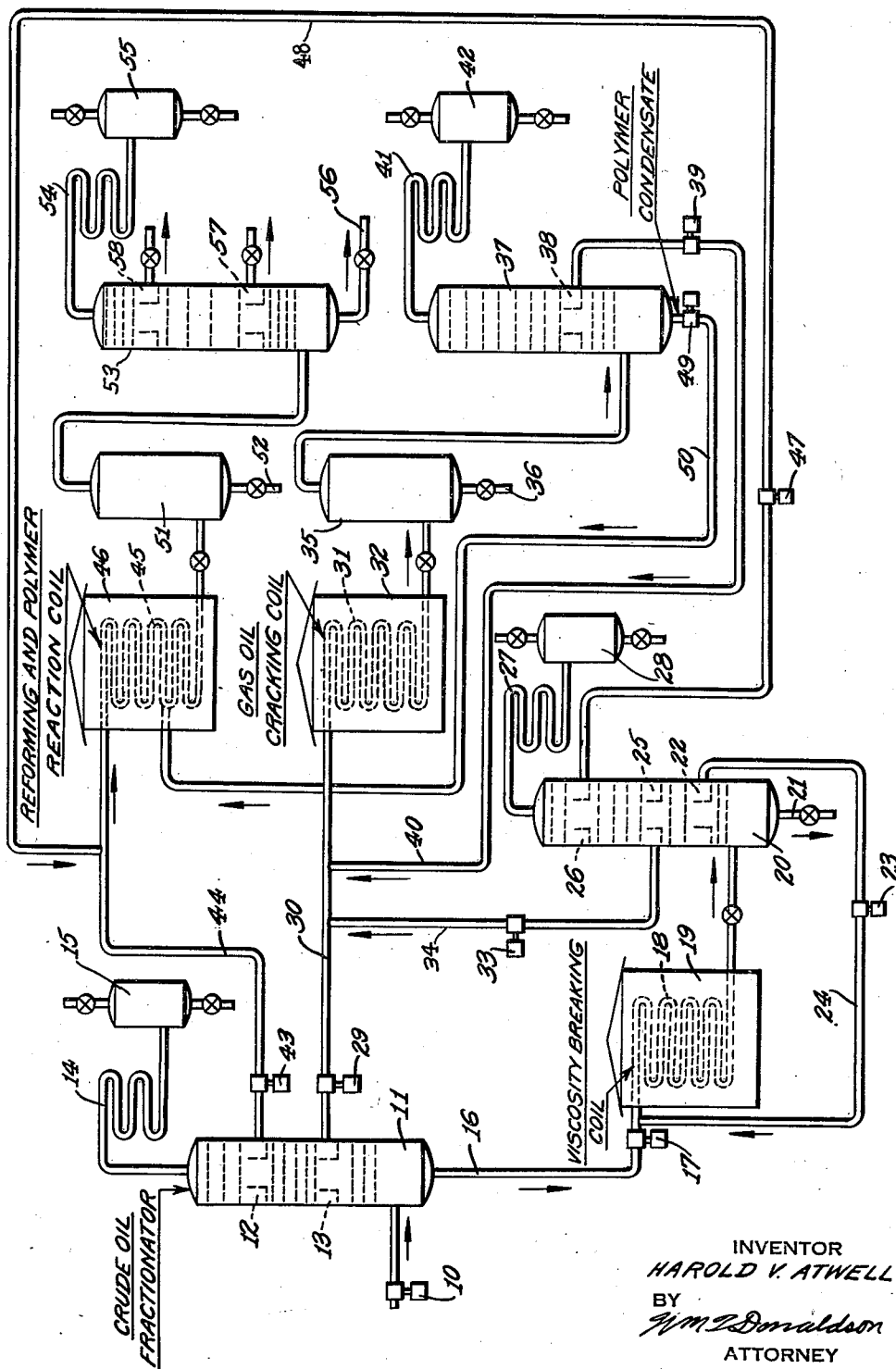
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H. V. ATWELL

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MANUFACTURE OF MOTOR FUEL

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INVENTOR
HAROLD V. ATWELL
BY
W. M. J. Donaldson
ATTORNEY

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MANUFACTURE OF MOTOR FUEL

Harold V. Atwell, Beacon, N. Y., assignor to
Gasoline Products Company, Inc., Jersey City,
N. J., a corporation of Delaware

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This invention relates to the production of motor fuels of the gasoline type as well as higher boiling motor fuels adapted for engines using heavy fuels.

It is a particular object of the invention to provide an improved fuel for spark ignition internal combustion engines, such as those of the Hesselman type, using fuel oils heavier than gasoline, but operating under moderate compressions as compared with the high compressions used in engines of the Diesel type which rely on compression for ignition.

In accordance with the invention, a high boiling motor fuel having an extremely high concentration of naphthenic and aromatic hydrocarbons and possessing high anti-knock value, is made while simultaneously making a high anti-knock motor fuel of the gasoline type.

The invention contemplates a process in which a charging stock, such as gas oil or kerosene, is subjected to cracking to effect conversion into lower boiling hydrocarbons, the resulting cracked products separated into vapors and residue and the separated vapors fractionated to separate out a condensate, higher boiling than the charging stock, comprising products of polymerization and containing a high concentration of cyclic compounds including naphthenic and aromatic hydrocarbons. This polymer condensate is then combined with a low boiling hydrocarbon fraction, such as gasoline, undergoing cracking or reforming and is subjected to partial conversion into lower boiling constituents of increased anti-knock quality and combination with polymer products produced in the reforming operation. The resulting products produced in the conversion of these combined stocks are then fractionated to recover the desired anti-knock gasoline and a higher boiling fuel product of high anti-knock quality.

A feature of the invention is the introduction of the polymer or cyclic condensate into an intermediate point in the light hydrocarbon cracking or reforming zone so as to provide a shorter time of reaction for the polymer condensate than is used in the cracking or reforming of the light oil.

The invention furthermore contemplates a combination cracking process for the processing of a crude oil charging stock for the production of both anti-knock gasoline and a higher boiling anti-knock motor fuel in which the crude petroleum is fractionated to form a crude residue, a low boiling fraction and a higher boiling condensate fraction, in which the residue is subjected

to cracking and the resulting cracked products separately fractionated to obtain a low boiling fraction and a higher boiling condensate fraction, in which the low boiling fractions from the crude distillation and from the cracking of the residue are subjected to cracking or reforming, in which the higher boiling straight-run condensate and the higher boiling condensate from the cracking of the residue are passed to a cracking zone and subjected to cracking conditions to effect conversion into anti-knock gasoline constituents, in which the resulting cracked products are separated into vapors and residue and the vapors fractionated to recover a condensate higher boiling than that of the condensate fraction charged to such cracking zone and containing a large proportion of cyclic compounds produced by polymerization, in which this cyclic or polymer condensate is introduced into the low boiling hydrocarbon cracking or reforming zone for conversion and reaction therein with the low boiling constituents undergoing conversion and in which the resulting products of conversion are fractionated to recover the desired low boiling and high boiling motor fuels of high anti-knock value.

For the purpose of more completely disclosing the invention, reference will now be had to the accompanying drawing which is a diagrammatic elevation of an apparatus adapted for practicing a particular embodiment of the invention.

In the apparatus thus illustrated, the crude petroleum charging stock, after being heated to a desired distilling temperature by heat exchange with cracked products of the system or by other heating means, is introduced by a pump 10 to a stripping and fractionating tower 11, the heated oil is separated into vapors and residue in the tower and the vapors are fractionated to form a naphtha fraction collecting in tray 12 and a higher boiling condensate collecting in tray 13. Light gasoline constituents, which may not require reforming, pass overhead as vapors to a condenser 14 and the distillate is collected in a receiving drum or gas separator 15.

Crude residuum is drawn from the tower 11 through a line 16 and directed by a pump 17 to a heating coil 18, positioned in furnace 19 adapted for supplying cracking temperature to effect cracking or viscosity-breaking of the residue and effect conversion into intermediate constituents as well as into gasoline constituents. The resultant viscosity-broken products are separated into vapors and residue in a separating and fractionating tower 20 from which the residue may be withdrawn through a line 21. The upper sec-

tions of the tower 20 are equipped with suitable fractionating elements and cooling means to effect fractionation of the separated vapors. Primary or heavy reflux condensate collecting in a tray 22 may be cycled by a pump 23 through a line 24 to the viscosity-breaking coil 18. Intermediate or gas oil condensate is collected in tray 25 and a naphtha condensate is collected in tray 26. Light gasoline constituents which may not require reforming, pass overhead from the tower 20 to a condenser 27 and the distillate is collected in a distillate receiver or gas separator 28.

The condensate fraction collecting in tray 13 of tower 11 is conducted by a pump 29 through a line 30 to a heating coil 31 positioned in a furnace 32 adapted for supplying the desired cracking temperature. Intermediate condensate from tray 25 of tower 20 is also charged to heating coil 31 by a pump 33 and line 34. The resultant cracked products pass into a reaction chamber or separator 35 wherein separation of vapors from residue takes place. The residue is withdrawn through a line 36 and the separated vapors pass to a fractionating tower 37 which is provided with conventional fractionating elements and cooling means to accomplish the desired fractionation. The fractionation is so conducted in the tower 37 as to segregate at the bottom of the tower a reflux condensate higher boiling than that of the charge to the cracking coil 31, while a lower boiling condensate, higher boiling than gasoline, is collected in a tray 38. The latter condensate may be cycled by a pump 39 and line 40 to the cracking coil 31. Gasoline or naphtha constituents pass overhead from the tower as vapors to a condenser 41 and the distillate is collected in a receiving drum or gas separator 42.

The naphtha fraction collecting in the tray 12 of the crude stripping tower 11 is conducted by a pump 43 through a line 44 to a heating coil 45 positioned in furnace 46 and adapted for heating the naphtha to a cracking temperature adequate to effect reforming into constituents of increased anti-knock quality. Viscosity-breaker naphtha collecting in tray 26 of tower 20 may be charged by pump 47 and line 48 to the reforming coil 45. The heavy cyclic condensate collecting in the bottom of tower 37 is conducted by pump 49 through line 50 by which it is introduced into an intermediate point of the coil 45. The resultant products of reaction pass from the coil 45 into a reaction chamber or separator 51 in which the vapors may be separated from any residual products of reaction, the tar or residue being withdrawn through a line 52. The separated vapors pass to a fractionating tower 53 which is provided with conventional fractionating elements and cooling means to effect the desired fractionation. Vapors of desired distillation range for gasoline pass overhead from the tower to a condenser 54 and the distillate is collected in a receiving drum or gas separator 55. Higher boiling cyclic condensate may be withdrawn through a line 56. A plurality of trapout trays, as 57 and 58, may be provided for the collection of particular fractions of cyclic or polymer condensate.

The fraction collecting in receiver 55 constitutes a desired gasoline type of motor fuel which may be blended with the cracked gasoline collecting in receiver 42 and may be subjected to such rectification as may be desired. The fraction withdrawn through line 56 or withdrawn from any of the trays 57 and 58, contains a high concentration of cyclic compounds, being rich in

aromatics and naphthenes, and constitutes the desired higher boiling motor fuel product of high anti-knock value. This product may be blended with other high anti-knock distillate of suitable boiling range, such as heavy polymers produced in gas polymerization or the products of gas pyrolysis or gas reversion for the preparation of a high grade fuel for internal combustion engines using heavy motor fuels.

In practicing the invention the crude oil may be distilled to produce a residue of about 650° F. to 750° F. initial boiling point, a gas oil cut having a boiling range of 500° F. or 550° F. up to about 750° F. and a heavy naphtha cut having a boiling range of 250° F. up to about 500° F. or 550° F. The residue is subjected to viscosity-breaking under suitable conditions of temperature and pressure to effect conversion into a high yield of intermediate constituents as well as into gasoline constituents. The vapors from the viscosity-breaking operation are fractionated in tower 20 to separate a reflux condensate at 22 having a higher boiling range than that of the material which it is desired to subject to cracking in the gas oil cracking coil 31 and this high boiling condensate is cycled to the viscosity-breaking coil 18. In lieu of cycling this condensate to the coil 18, it may advantageously be passed to a separate cracking zone and the cracked products returned to the tower 20. The intermediate condensate collecting in tray 25 may comprise constituents of similar boiling range to that of the straight-run gas oil and the mixture of straight-run and viscosity-breaker gas oil, together with the cycle condensate withdrawn from tray 38 which may have a boiling range of about 400° F. to 700° F. or 750° F. is subjected to cracking under suitable conditions of temperature and pressure but preferably under conditions of relatively high cracking per pass so as to effect conversion into high anti-knock gasoline. The heavy cyclic or polymer condensate collected at the base of tower 37 may have an initial boiling point of the order of 700° F. or 750° F., the exact temperature depending upon the endpoint of the oil charged to the cracking coil 31. In any case, the polymer condensate will consist largely of constituents boiling in the range of 750° F. to 850° F. (determined by vacuum distillation and interpolated to an atmospheric pressure basis). The viscosity-breaker naphtha fraction withdrawn from tray 26 and admixed with straight-run naphtha withdrawn from tray 12 of tower 11 may have a boiling range similar to that of the straight-run naphtha and the mixture is subjected to conditions of temperature and pressure in the coil 45 adapted for accomplishing the desired reformation into constituents of increased anti-knock quality. This temperature will be in excess of 850° F. and is preferably of the order of 900° F. or 1000° F. The pressure employed in the reforming of the naphtha and in the conversion of the heavy polymer condensate which undergoes reaction with the naphtha, is preferably relatively high, such as of the order of 600 to 1000 pounds.

In a specific example of the invention, crude residue having an initial boiling point of 700° F. is subjected to viscosity-breaking in coil 18 at a temperature of 900° F. under 400 pounds pressure, a fraction having an initial boiling point of 700° F. being withdrawn from tray 22 and cycled to the heating coil 18. An intermediate fraction having a boiling range of 500° F. to 700° F. is withdrawn from tray 25 of tower 20 and

combined with a similar boiling range cut of gas oil taken from tray 13 of the crude stripping tower and the mixture is subjected to cracking in coil 31 at a temperature of 950° F. under 400 pounds pressure. The vapors from the cracking operation are fractionated in tower 37 to form a condensate at the bottom of the tower having an initial boiling point of about 700° F. and consisting substantially entirely of components boiling above those of the oil charged to the cracking coil 31. Cycle condensate having a boiling range of 400° F. to 700° F. is withdrawn from tray 38 and cycled to the heating coil 31 while gasoline distillate of 400° F. endpoint is collected in receiving drum 42. A straight-run naphtha fraction having a boiling range of 250° F. to 450° F. is withdrawn from tray 12 of the crude stripping tower and combined with a similar naphtha fraction withdrawn from tray 26 of the tower 20 for passage to the reforming coil 45. The naphtha is raised to a temperature of 950° F. in the first portion of the heating coil 45 and subjected to reforming, and the heavy cyclic product withdrawn from tower 37 is combined with the naphtha undergoing reforming. The mixture undergoes reaction in the subsequent portions of the heating coil at a temperature of about 850° F.-900° F. while under pressure of about 800 pounds. A gasoline product of 400° F. endpoint is separated from the higher boiling reflux condensate and collected as a distillate in receiver 52 while higher boiling condensate of desired boiling range and viscosity and consisting predominantly of polymer products of reaction is withdrawn from the tower to constitute the high boiling motor fuel rich in aromatic and naphthenic compounds.

It is advantageous to charge to the reforming coil 45 a naphtha fraction having approximately the same endpoint as that desired for the gasoline distillate collected in receiver 55 in which case the high boiling motor fuel product withdrawn from the tower 53 will consist entirely of polymer products of reaction.

In one method of practicing the invention, the crude residuum as withdrawn from tower 11, instead of being subjected to a viscosity-breaking operation, is subjected to coking for immediate conversion into a maximum yield of overhead products and the vapors from the coking operation are fractionated to separate out a gas oil stock of desired boiling range which is combined with the straight-run gas oil and the mixture subjected to cracking, while straight-run naphtha as well as naphtha from the coking operation, if desired, is subjected to a separate reforming operation and a polymer condensate, consisting essentially of constituents higher boiling than the gas oil charged to the gas oil cracking zone, is separated out from the resultant products of the gas oil cracking and directed to the reforming zone, particularly to an intermediate point therein, for partial conversion into lower boiling constituents within the gasoline boiling range and for combination with naphtha constituents undergoing reforming to form high boiling anti-knock motor fuel as well as anti-knock motor fuel of the gasoline type.

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

I claim:

1. In the manufacture of motor fuel, the process that comprises subjecting a naphtha stock in a reforming zone to cracking temperature adequate to effect reformation into gasoline constituents of increased anti-knock quality, subjecting a higher boiling charging stock of given boiling range in a separate cracking zone to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons and higher boiling polymer products, separating the resultant cracked products into vapors and residue, fractionating the separated vapors to separate from lower boiling products a completely synthetic polymer product consisting essentially of constituents higher boiling than said higher boiling stock, directing said polymer product to said reforming zone for conversion and combination with reaction products of the reforming and subjecting the commingled constituents to conversion in the absence of any added constituents higher boiling than said naphtha stock, separating the resultant products of conversion from the reforming zone into vapors and residue, and fractionating the separated vapors to separate a gasoline product from a higher boiling completely synthetic condensate comprising polymer products of reaction and withdrawing the condensate as another product of the process.

2. In the manufacture of motor fuel, the process that comprises subjecting a naphtha stock in a reforming zone to cracking temperature adequate to effect reformation into gasoline constituents of increased anti-knock quality, subjecting a higher boiling charging stock of given boiling range in a separate cracking zone to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons and higher boiling polymer products, separating the resultant cracked products into vapors and residue, subjecting the separated vapors to fractionation to form a gasoline distillate, an intermediate condensate higher boiling than gasoline and a completely synthetic condensate consisting essentially of polymer products of reaction higher boiling than said higher boiling charging stock, directing said synthetic condensate to said reforming zone for conversion and combination with reaction products of the reforming and subjecting the commingled constituents to conversion in the absence of any added constituents higher boiling than said naphtha stock, separating the resultant products of conversion from the reforming zone into vapors and residue, and fractionating the separated vapors to separate a gasoline product from a higher boiling completely synthetic condensate comprising polymer products of reaction and withdrawing the condensate as another product of the process.

3. In the manufacture of motor fuel, the process that comprises fractionating crude petroleum to produce a residue, a gas oil fraction and a naphtha fraction, subjecting said residue to cracking conditions of temperature and pressure to effect conversion into lower boiling products, separately fractionating the resultant cracked products to obtain a gas oil fraction and a naphtha fraction, combining said naphtha fractions and subjecting the mixture in a reforming zone to cracking temperature adequate to effect reformation into gasoline constituents of increased anti-knock quality, combining said gas oil fractions and subjecting the mixture in a separate cracking zone to cracking conditions of

temperature and pressure to effect conversion into lower boiling hydrocarbons and higher boiling polymer products, separating the resultant cracked products into vapors and residue, subjecting the separated vapors to fractionation to form a gasoline distillate, an intermediate condensate higher boiling than gasoline and a completely synthetic condensate consisting essentially of polymer products of reaction higher boiling than said gas oil, directing said synthetic condensate to said reforming zone for conversion and combination with reaction products of the

reforming and subjecting the commingled constituents to conversion in the absence of any added constituents higher boiling than said naphtha stock, separating the resultant products of conversion from the reforming zone into vapors and residue, and fractionating the separated vapors to separate a gasoline product from higher boiling completely synthetic condensate comprising polymer products of reaction and withdrawing the condensate as another product of the process.

HAROLD V. ATWELL.