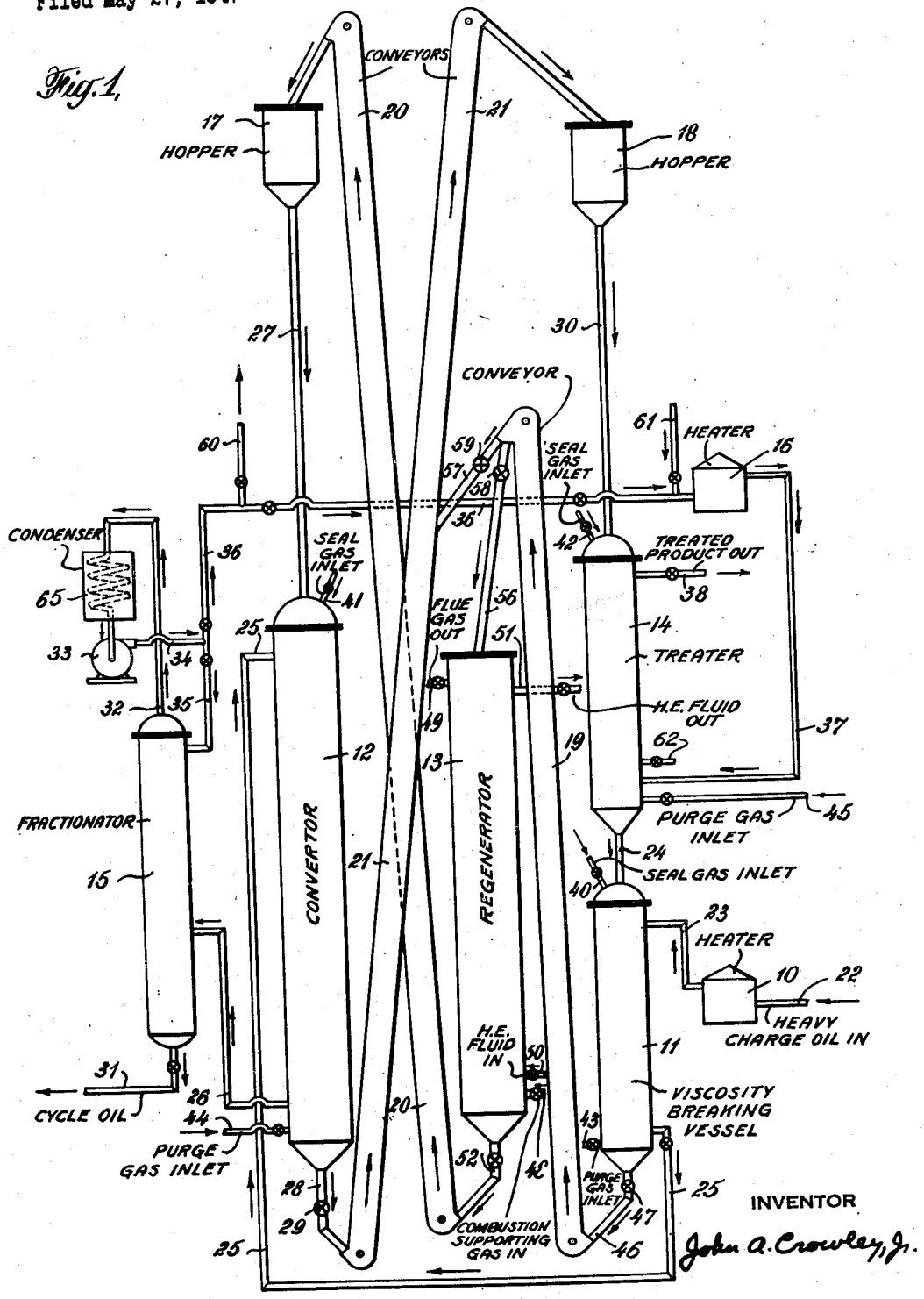
March 15, 1949. J. A. CROWLEY, JR 2,464,489

METHOD FOR HYDROCARBON CONVERSION

Filed May 27, 1947

2 Sheets-Sheet 1

Fig. 1.



INVENTOR

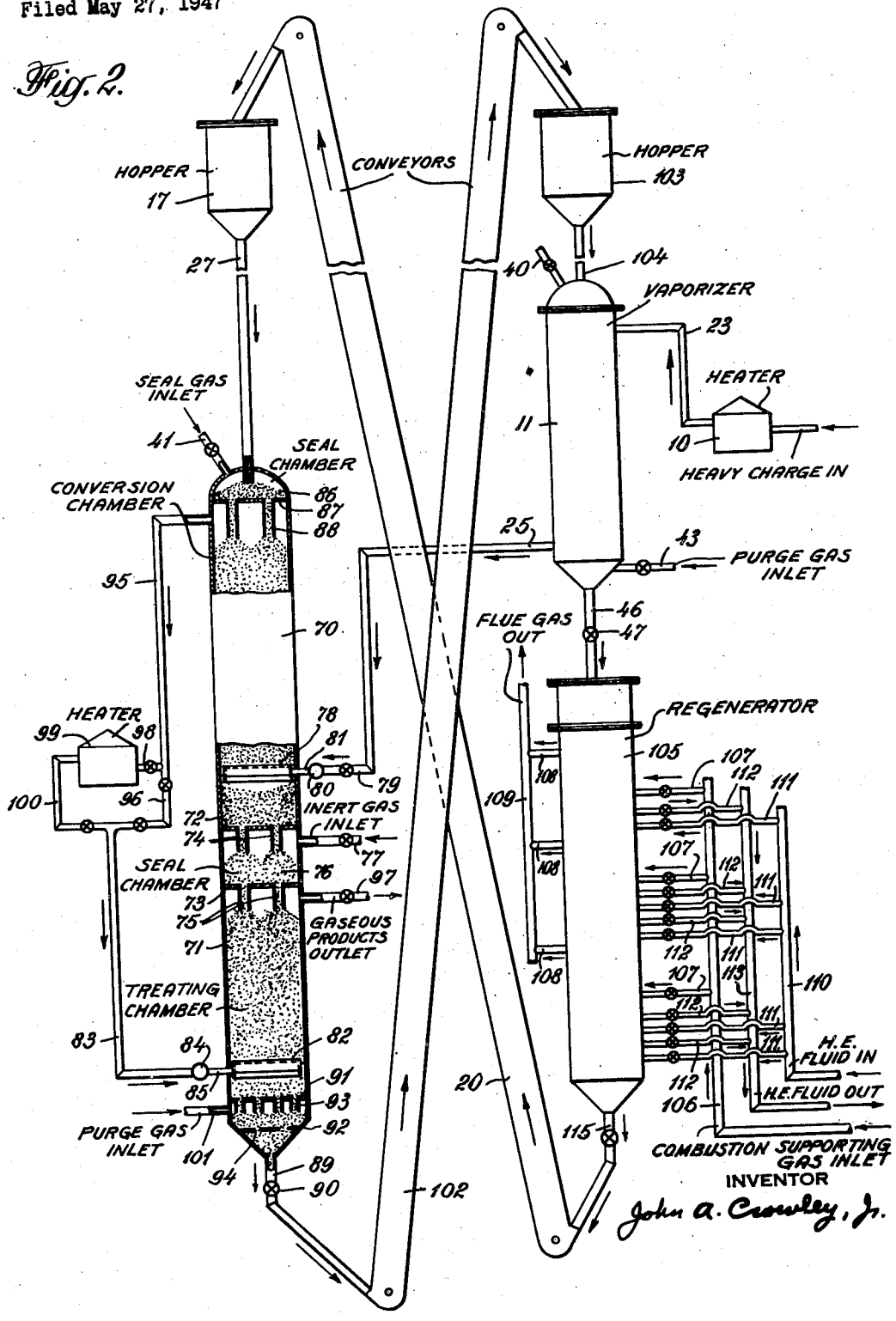
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METHOD FOR HYDROCARBON CONVERSION

Filed May 27, 1947 2 Sheets-Sheet 2

Fig. 2.



INVENTOR

John A. Crowley, Jr.

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2,464,489

UNITED STATES PATENT OFFICE

2,464,489

METHOD FOR HYDROCARBON CONVERSION

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Application May 27, 1947, Serial No. 750,729

17 Claims. (Cl. 196—52)

1

This invention pertains to a method for conversion of high boiling hydrocarbons to lower boiling hydrocarbon products containing substantial amounts of material boiling within the range of aviation and motor gasoline. The invention is particularly directed to an improved process for the continuous catalytic conversion to gasoline containing products of liquid hydrocarbon fractions which boil for the most part above the desired conversion temperature.

It is well known that high boiling hydrocarbons such as gas-oil, for example, when contacted in the vapor phase with a suitable solid adsorbent material at temperatures of the order of 800° F. and usually at pressures above atmospheric, may be converted to lower boiling gaseous, gasoline containing products. Until recently, most commercial catalytic hydrocarbon cracking processes have involved the use of selected cracking stocks which consist of material which may be vaporized without undergoing substantial pyrolytic conversion prior to being contacted with the solid catalyst. Recently certain catalytic processes for handling heavier liquid charging stocks have been developed in which the heavy liquid petroleum charged is mixed with a hot catalyst coming from a catalyst regenerator so as to effect vaporization of the liquid oil after which the mixed catalyst and oil vapors are passed through a conversion zone to effect final conversion of the vaporized hydrocarbons to gasoline containing products. In such processes the heat for vaporization of the liquid hydrocarbons and the heat of conversion thereof is all supplied by the hot regenerated catalyst initially contacted with the liquid oil. This means that the hydrocarbon charge is initially contacted with a very active catalyst at temperatures far in excess of the desired cracking conversion temperature at a relatively high catalyst to oil ratio, resulting in excessive dry gas and coke yields and inferior gasoline yields. Moreover, the total range of catalyst temperatures from the beginning to the end of its contact with the hydrocarbons is undesirably wide.

A major object of this invention is the provision of a practical continuous catalytic process capable of handling liquid hydrocarbons boiling above the desirable average conversion temperature without substantial pyrolytic conversion thereof to coke and non-condensable gas.

A specific object of this invention is the provision of a combined catalytic process for viscosity-breaking, cracking and treating of hydrocarbon fractions.

2

Another specific object of this invention is the provision of a continuous method for conversion of petroleum residuums to gasoline containing products in the presence of a moving solid catalyst while maintaining suitable conversion temperatures and a low catalyst to oil ratio throughout the conversion.

These and other objects will become apparent from the following description of this invention. Before proceeding with this description, certain terms used herein in describing and in claiming this invention will be defined. The term "gaseous" as in "gaseous hydrocarbons" is used herein in a broad sense as including not only normally gaseous materials but material existing in the gaseous phase under the existing operating conditions regardless of the phase of that material at normal atmospheric conditions. The terms "high boiling liquid petroleum fraction" and "high boiling liquid hydrocarbon charge" are intended to mean a petroleum fraction or hydrocarbon charge wherein at least the major portion of the material boils at temperature above the desirable average catalytic conversion temperature for said fraction or charge.

The present invention involves a system wherein the high boiling liquid, hydrocarbon charge is contacted in a viscosity breaking zone with a contaminant bearing contact material which contains sufficient heat only to accomplish a viscosity breaking of said liquid charge to convert it into lower boiling gaseous hydrocarbons which are then further converted to still lower boiling gasoline containing products in a separate conversion zone wherein it is contacted in the vapor phase with a freshly regenerated contact material maintained within a suitable temperature range for the desired conversion. The used contaminant bearing catalyst is separated from the gasoline containing conversion products and passed through a separate treating zone wherein it is contacted with a suitable heated gaseous hydrocarbon fraction under such conditions as to effect a treatment of the hydrocarbon fraction and as to effect a rise in the catalyst temperature to a level which is substantially above the level of its withdrawal from said conversion zone and which is suitable for its introduction to said viscosity-breaking zone. The used, heated catalyst then passes to said viscosity-breaking zone as the catalyst charge thereto.

The treating zone referred to hereinabove may be one wherein any of a number of different types of hydrocarbon treatment is effected. The treatment effected may be catalytic hydrocarbon de-

hydrogenation reaction, a naphtha or gasoline reforming reaction, a hydrocarbon aromatization reaction, a desulfurization reaction, a hydrocarbon partial oxidation reaction, an isoforming reaction or a reaction of gaseous hydrocarbons with steam, for example. It will be understood that the word "treatment" as employed herein in describing and in claiming this invention is employed in a broad sense as covering any of the above and related suitable reactions.

It is contemplated that in its broader scope, the method of this invention may be conducted either as a powdered catalyst suspension or fluidized mass process or as a granular catalyst moving bed type of process. In its preferred form, this invention contemplates the use of a moving bed type process because of certain important operational advantages offered thereby.

The contact material employed may partake of the nature of natural or treated clays, bauxites, or synthetic associations of silica, alumina or silica and alumina. Also the catalyst may take the form of mixtures of metallic oxides, particularly of those from the III and VI groups of the periodic system to which mixture oxides of silica or silica may be added. Other catalysts may consist of carriers such as alumina, carborundum, etc., upon which promoters, usually consisting of certain metallic oxides have been deposited. The exact nature of the catalyst employed will vary depending upon the particular hydrocarbon reactants involved and upon the type of treatment to be accomplished in the treating step. For example where the reaction in the treating zone involves dehydrogenation at least some of the catalyst may take the form of an alumina carrier with chromium oxide deposited thereon. Where the reaction involved in the treating zone is aromatization at least some of the catalyst may take the form of alumina bearing deposits of vanadium or chromic oxide. Where the reaction in the treating zone involves the reaction of ethane in the presence of steam to form olefins, a nickel bearing catalyst is desirable. For isoforming, reforming and certain partial oxidation reactions in the treating zone a silica alumina adsorbent catalyst is suitable. It is also contemplated that mixtures of two or more different types of catalysts may be employed. The size of the catalyst particles will vary depending upon the type process involved. For suspension type processes the catalyst will be in the form of a powder of about 100 mesh and finer as determined by Tyler standard screen analysis. For the moving bed type process the contact material may consist of particles ranging from below 4 mesh to about 60 mesh and preferably from about 4 to 16 mesh.

This invention may be most readily understood by reference to the drawings attached hereto of which Figure 1 is an elevational view showing a preferred arrangement of a system adapted for the process of this invention and Figure 2 is an elevational view, partially in section, of a modified form of this invention. Both of these drawings are highly diagrammatic in form.

Turning now to Figure 1, which shows a preferred form of this invention, there is shown a charge oil heater 10, a viscosity-breaking vessel 11, a convertor 12, a catalyst regenerator 13, a treating vessel 14, a fractionating tower 15 and a heater 16 for preheating the hydrocarbon charge to treater 14. Also shown are convertor and treater supply hoppers 17 and 18 respectively, conveyor 19 for conveying catalyst from viscosity-breaking vessel 11 to the regenerator 13, conveyor 20 for transferring catalyst from the regenerator to convertor supply hopper 17 and a conveyor 21 for transferring used catalyst from convertor 12 to the treater supply hopper 18. The system shown is a moving bed type system and the conveyors should be of a type adapted to transfer catalyst particles at elevated temperatures without excessive attrition thereof. For example, continuous bucket elevators have been found to be suitable for this purpose.

In operation a high boiling liquid hydrocarbon fraction such as a petroleum residuum may be introduced through pipe 22 to heater 10 wherein it is heated to a suitable temperature which is below its vaporization and pyrolytic cracking temperature, and then passed via conduit 23 as a heated liquid into the upper section of vessel 11. Within the viscosity-breaking vessel the liquid charge is distributed onto a substantially compact column of downwardly moving contaminant bearing catalyst particles. The column is continuously replenished by a stream of hot carbonaceous contaminant bearing catalyst entering through conduit 24 at a temperature sufficiently high to support a viscosity-breaking conversion of the liquid hydrocarbon charge to a lower boiling gaseous hydrocarbon fraction suitable for vapor phase catalytic cracking, without the catalyst temperature in said viscosity-breaking zone falling below a suitable level for the viscosity-breaking reaction or to a level that would cause substantial condensation of the viscosity-broken fraction. The liquid charge to vessel 11 passes downwardly within the column of catalyst and is converted to a lower boiling gaseous fraction which is withdrawn from the lower section of vessel 11 through conduit 25. The viscosity-broken fraction is passed as a vapor without substantial cooling via conduit 25 into the upper section of convertor 12. It then passes downwardly through a column of downwardly moving catalyst particles within vessel 12 to become converted to lower boiling gaseous gasoline containing products which are withdrawn from the lower section of convertor 12 via conduit 26. The column of catalyst from convertor 12 is continuously replenished with hot freshly regenerated catalyst supplied from hopper 17 into the upper end of convertor 12 through an elongated confined gravity feed leg 27. The contact material so supplied to convertor 12 is supplied at a rate and temperature suitable for supplying the endothermic heat of the hydrocarbon conversion accomplished in vessel 12. Inasmuch as the hydrocarbon charge to convertor 12 is a heated viscosity-broken vapor the heat for the viscosity-breaking or vaporizing operation need not be supplied by the catalyst entering convertor 12. The used catalyst, having been cooled somewhat by virtue of it supplying the endothermic heat for the hydrocarbon conversion in vessel 12 and bearing a carbonaceous contaminant deposit is withdrawn from convertor 12 substantially separately from the gaseous conversion products through conduit 28 at a suitable rate controlled by valve 29. The used catalyst is transferred by conveyor 21 to hopper 18 and then passes via gravity feed leg 30 into the top of an elongated treating vessel 14. The gasoline containing product from convertor 12 is passed via conduit 26 to a suitable conventional fractionator 15 wherein a gasoline and lighter or kerosene and lighter fraction is separated from a heavier cycle oil fraction. The cycle oil fraction is withdrawn from the bottom

of fractionator 15 via conduit 31 and the lighter fraction is withdrawn from the top of tower 15 as a vapor through conduit 32. The vapor fraction is condensed in condenser 65. Part of the condensate is pumped by pump 33 via conduits 34 and 35 back to the tower 15 as reflux. The remainder of the condensate is pumped via conduits 34 and 36 to heater 16 wherein it is vaporized and preheated to a temperature substantially above the temperature at which the used catalyst was withdrawn from convertor 12. The preheated kerosene and lighter or gasoline and lighter fraction passes from heater 16 via conduit 37 into the lower section of treater 14 to contact a substantially compact column of the used catalyst maintained therein. The preheated vapors pass upwardly through the column in vessel 14 so as to become treated and also so as to heat the catalyst to a temperature which is substantially above the level of its withdrawal from convertor 12 and which is suitable for its introduction into vessel 11. The treated gaseous products are withdrawn from the upper section of vessel 14 via conduit 38 and the used heated catalyst passes via conduit 24 from treater 14 to viscosity-breaking vessel 11. The escape of hydrocarbon vapors from the catalyst supply ends of vessels 11, 12 and 14 is prevented by the introduction of a suitable inert seal gas such as steam or flue gas into the upper ends of said vessels through conduits 40, 41 and 42 respectively at a rate sufficient to maintain a seal blanket of inert gas within the upper ends of said vessels. Similarly the escape of gaseous reactants with the catalyst discharged from the lower ends of vessels 11, 12 and 14 is prevented by the introduction of an inert purge gas through conduits 43, 44 and 45 respectively to said vessels so as to purge the outflowing catalyst substantially free of gaseous reactants. The used catalyst discharged from vessel 11, bearing contaminant deposited thereon in vessels 12, 14 and 11 is passed from vessel 11 via conduit 46 at a suitable rate controlled by valve 47 to conveyor 19 by which it is transferred to regenerator 13. The spent contact material passes as a substantially compact column downwardly through vessel 13 while being contacted with a combustion supporting gas such as air, oxygen or mixtures of air and flue gas introduced at 48 and withdrawn at 49. The contaminant deposits are in this manner burned off from the catalyst, and a sufficient amount of the heat released by such burning is removed from the catalyst by means of a suitable heat exchange fluid passed through heat transfer tubes (not shown) within vessel 13 to prevent the catalyst temperatures from rising to a level which would cause serious permanent heat damage to its catalytic effectiveness for the hydrocarbon conversion reactions. The heat exchange fluid may be supplied to said heat transfer tubes through conduit 50 and withdrawn therefrom through conduit 51. The regenerated catalyst passes from the regenerator 13 through conduit 52 and is transferred by conveyor 20 to convertor supply hopper 17.

In some operations in order to permit reduction in the catalyst to oil ratio within the convertor 12, it is desirable to recycle some of the used catalyst from the viscosity-breaking vessel 11 to the treating vessel 14. This may be accomplished by discharging part of the used catalyst from conveyor 19 through duct 56 to regenerator 13 and part through duct 57 to conveyor 21 by which it is transferred to hopper 18 supplying

treating vessel 14. The proportion of the catalyst so recycled may be controlled by means of valves 58 and 59 on ducts 56 and 57 respectively.

It will be noted that in the above described system the direction of flow of hydrocarbon reactants in the viscosity-breaking and conversion zones is concurrent to the direction of catalyst flow while in the treating zone the direction of reactant flow is countercurrent to the catalyst flow. While it is contemplated that within the scope of this invention the direction of reactant and catalyst flow may be either concurrent or countercurrent or partially both in the viscosity-breaking and conversion zones, the preferred flow is as shown in Figure 1, because it permits of lower reactant outlet temperatures from said zones and consequently of lower catalyst inlet temperatures to said zones. In other words, the type of flow shown in Figure 1, permits the accomplishment of the desired conversion at the lowest possible initial catalyst oil contact temperatures thereby avoiding very high dry gas and coke make which occurs at excessive reaction temperatures. On the other hand, since the catalyst in the treating zone is either partially or entirely heated to the desired temperature for its introduction into the viscosity-breaking zone by the preheated hydrocarbon fraction introduced to said treating zone it is important that the reactant flow be countercurrent to the catalyst flow in the treating zone, otherwise the required temperature of preheat in heater 16 would be so excessive as to cause undesirable pyrolytic decomposition of the hydrocarbon fraction within the tubes of heater 16.

If desired, the dry gas formed in convertor 12 may be separated from a gasoline or naphtha fraction and only the gasoline or naphtha fraction may be treated in treating vessel 14. Also in some operations it may be desirable to treat only a portion of the fractionated lower boiling conversion products, in which case a portion of these products may be withdrawn from conduit 36 at conduit 60. In many operations particularly where the fraction passed through treating zone 14 is a gasoline or naphtha fraction, which undergoes a reforming in zone 14, it is desirable to separate out a light gasoline cut from the products from zone 14 in a suitable fractionator (not shown) and to recycle the heavier portion of the productfs or at least a naphtha cut to the treating chamber for further reforming of said cut. The recycle stream may be supplied to the heater 16 at 61 where it joins the hydrocarbon fraction from fractionator 15. This procedure is also important in that it permits the addition of the required amount of heat to the catalyst in zone 14, while allowing considerable flexibility as to the required preheat temperature to which the fraction is heated in heater 16. In still other operations the hydrocarbon fraction charged to treating vessel 14 may consist entirely or partially of outside hydrocarbons introduced into conduit 36 through conduit 61. Thus, for example, the charge to the heater 16 introduced at 61 may consist substantially of propane and steam which after being heated to about 1050° F. is introduced into treating vessel 14 so as to effect a conversion of the propane to unsaturated hydrocarbons. In another example, the charge to heater 16 may be a gasoline or a dry gas fraction heated to about 900° F.–1000° F. which then enters vessel 14 and is caused to be partially ox-

idized therein by oxygen introduced into vessel 14 at a controlled rate through conduit 62 so as to produce oxygen containing gaseous organic products. It will be noted that in the latter example and in the case of some other reactions which may be conducted in vessel 14, the reaction is exothermic so that all or part of the heat required for heating the catalyst in vessel 14 to a suitable temperature for its subsequent use in the viscosity-breaking operation is supplied by the treating reaction conducted within vessel 14. It will be apparent, therefore, that the exact temperature to which the hydrocarbon fraction is heated in heater 16 will depend to a large extent upon whether the reaction in treating vessel 14 is endothermic or exothermic. In general the reaction conducted in vessel 14 should be exothermic or only mildly endothermic. Strongly endothermic reactions should be avoided. In general the hydrocarbon charge to treater 14 should boil below about 600° F. and preferably within gasoline-kerosene boiling range.

Turning now to Figure 2, there is shown a somewhat modified form of this invention. In Figures 1 and 2, identical apparatus elements bear the same numerals. In the arrangement of Figure 2, the conversion chamber 70 and treating chamber 71 are provided with the same vessel. Vertically spaced partitions 72 and 73, with dependent catalyst flow tubes 74 and 75 respectively are positioned across the vessel at an intermediate section of its length so as to define between the upper conversion chamber 70 and the lower treating chamber 71, an intermediate seal chamber 76. An inert seal gas such as steam may be introduced through conduit 77 into chamber 76 at a sufficient rate to prevent substantial interflow of reactants between chambers 70 and 71. A row of spaced inverted gable-roofed gas distributing troughs 78 is positioned across the lower section of conversion chamber 70. These troughs are supplied from conduit 79 through manifold 80 and pipes 81. A similar row of troughs 82, supplied from conduit 83, manifold 84 and pipes 85 is provided in the lower section of the treating chamber 71. Catalyst is supplied from supply hopper 17 through gravity feed leg 27 into the seal chamber 86 defined by partition 87 within the vessel above chamber 70. An inert seal gas may be introduced into seal chamber 86 through conduit 41. Catalyst passes from seal chamber 86 to conversion chamber 70 through tubes 88 depending from partition 87. Catalyst is withdrawn from the bottom of the treating chamber 71 through conduit 89 at a suitable rate controlled by valve 90. In order to permit uniform withdrawal of catalyst from all sections of the vessel horizontal cross-sectional area and thereby to insure uniform catalyst flow in all sections of the conversion and treating chambers thereabove, a system of baffling is provided within the lower end of the treating chamber 71 just above the discharge conduit 89. This baffling system is comprised of at least two vertically spaced partitions 91 and 92 extending horizontally across the vessel. A plurality of uniformly spaced tubes 93 depend from partition 91. A smaller plurality of orifices 94 are positioned in partition 92 in such a manner that each orifice receives proportionate flow from a plurality of tubes 93 thereabove. The plurality of streams flowing through the orifices 94 are proportionately combined into the surge outlet stream flowing in conduit 89.

This latter arrangement permits the uniform withdrawal of catalyst from all portions of the horizontal cross-sectional area at the lower end of zone 71 to the single outlet conduit 89.

In operation a liquid petroleum residuum is preheated in heater 10 and subjected to viscosity-breaking in vessel 11 as described under Figure 1, the viscosity broken vapors pass from the lower section of vessel 11 through conduit 25 to conduit 79 and thence via manifold 80, and pipes 81 under the distributing troughs in conversion chamber 70. The gaseous reactants flow upwardly through the column of catalyst in chamber 70 countercurrently to the catalyst flow so that the converted gaseous products leave the chamber 70 through conduit 95 at a substantially higher temperature than that at which they entered. In fact the hydrocarbon products withdrawn at 95 exist at a temperature nearly approaching the catalyst supply temperature to the conversion chamber. Meantime hot regenerated catalyst supplied to chamber 70 from supply hopper 17 gradually becomes cooled as it passes through the chamber 70. The used catalyst passes through tubes 74 into the seal chamber 76 and then through tubes 75 into treating chamber 71 at a temperature which is too low for its delivery to the viscosity-breaking chamber 11. It is heated to a suitable temperature for delivery to the viscosity-breaking chamber as it passes downwardly as a substantially compact column through chamber 71. This heating is accomplished by the passage of the hot reaction products from the conversion zone through conduit 95, by-pass 96, and conduit 83 to manifold 84 supplying tubes 85 which in turn direct the hot vapors into troughs 82 by which the vapors are distributed into the catalyst column within the lower section of treating chamber 71. The gaseous hydrocarbon products pass upwardly through chamber 71 being subjected to a catalytic reforming and at the same time heating the catalyst. The reformed gaseous products are withdrawn from the upper section of chamber 71 through conduit 97. In most operations, it is desirable to supplement the heat carried in the hydrocarbon vapors leaving conversion chamber 70 by passage of all or a portion of the vapors through conduit 98 to heater 99 and thence through conduits 100 and 83 to the treating chamber. The heated used catalyst now existing at a temperature suitable for converting a high boiling liquid charge to a lower boiling vaporized charge purged substantially free of reactant gases by means of a suitable inert purge gas introduced into the lower section of chamber 71 through conduit 101 and the catalyst is then withdrawn from chamber 71 via conduit 89 and transferred by conveyor 102 to hopper 103 supplying the viscosity-breaking vessel 11 through feed leg 104. The spent catalyst from vessel 11 passes via conduit 46 to regenerator 105 therebelow. The regenerator 105 is of the multi-stage variety, being provided with a series of superposed alternating burning and cooling zones. Air is supplied from manifold 106 into inlet pipe 107 feeding each burning zone. Flue gas is withdrawn from each burning zone through pipes 108 to manifold 109. A suitable heat exchange fluid is supplied from manifold 110 to pipes 111 feeding suitable coils or tubes within the cooling zones. Heat exchange fluid is withdrawn from the heat transfer tubes through pipes 112 which connect into an outlet manifold 113. The heat exchange fluid may take a number of forms, for example, it may be water under pressure, steam or a molten alloy or mixture of molten inorganic salts. The regenerated

catalyst is withdrawn from regenerator 105 via conduit 115 and is transferred by conveyor 20 to the convertor supply hopper 17 at a suitable temperature for introduction to the conversion chamber.

In the above described operation, in order to permit transfer of substantial amounts of heat from the conversion to the treating zones in the hydrocarbon reactants, it is important that the reactant vapor flow in both the conversion and treating zones be countercurrent to the direction of catalyst flow therein.

It will be understood that neither of the described modified arrangements of this invention is considered to be limited to the particular apparatus constructions shown. For example, other types of catalyst regenerators adapted for the regeneration of spent catalysts by burning of the contaminants at properly controlled temperatures may be substituted for the regenerator constructions shown in Figures 1 and 2. Moreover, other forms of design known to the art permitting the uniform distribution of gaseous reactants in the conversion and treating zones and for the disengagement of gaseous products from the catalyst column may be substituted for those described hereinabove. The same applies to means for introduction of catalyst into the several zones and for withdrawal of catalyst therefrom. Moreover the type of apparatus used may vary considerably depending upon the type of process and catalyst and reactants involved.

From the above it will be apparent that the method of this invention permits the conversion of high boiling petroleum residuums and the like to gasoline containing products under conversion conditions and catalyst to oil ratios which are comparable to those currently employed for the conversion of much lighter easily vaporizable, selected gas oil charging stocks. By separately conducting a viscosity-breaking operation on the original liquid charge and by providing the heat for said viscosity-breaking and vaporizing operation from a source other than the freshly regenerated catalyst obtained from the catalyst regenerator, it is possible to maintain temperature and catalyst to oil ratio and the catalyst activity conditions in the final cracking conversion zone essentially the same as would be maintained for originally clean gas oil charging stocks. Moreover, by utilizing a partially spent instead of a fresh catalyst for the viscosity-breaking operation and by utilizing a catalyst which contains only sufficient excess sensible heat for the viscosity-breaking operation instead of a catalyst which contains both the heat for the viscosity-breaking and the subsequent final cracking conversion operation, severe cracking conditions leading to excessive coke and dry gas makes are avoided in the viscosity-breaking operation. In addition, these desirable advantages are obtained while at the same time accomplishing a hydrocarbon treating operation which may result in a substantial upgrading of the anti-knock and other characteristics of the final gasoline product or in the provision of other valuable by-products from the overall operation.

The exact operating conditions employed in the viscosity-breaking, conversion, and treating zones will, of course, vary widely depending upon the particular catalyst and reactants involved and the desired reaction products. Certain broad ranges of operating conditions may, however, be given.

In the conversion zone the catalyst to oil ratios

employed may fall within the range about 2 to 8 parts by weight catalyst charged per part by weight of oil vapors charged per unit of time. The oil space velocity may fall within the range about 0.5 to 10 volumes of oil (measured as a liquid at 60° F.) per hour per volume of catalyst within the conversion zone (measured as the substantially compact mass as it flows). The catalyst inlet temperature to the conversion zone may be of the order of about 900° F. to 1100° F. and the catalyst outlet temperature may be of the order of about 800° F. to 1000° F. depending upon the particular operation involved.

Considering the viscosity-breaking zone, while it is contemplated that within the scope of this invention lighter original charging stocks may be employed, usually the charging stock will be a high boiling liquid such as a petroleum crude residuum which consists mainly of constituents boiling above about 800° F.–900° F. This liquid charge may be heated in heater 10 to a temperature, below that at which substantial pyrolytic conversion occurs in the time it passes through the heater, before charging to the viscosity-breaking and vaporizing zone, for example, temperatures of the order of 500° F. to about 850° F. The catalyst inlet temperature to the viscosity-breaking zone may fall within the range about 950° F. to 1150° F. and the catalyst outlet temperature within the range about 850° F. to 950° F. The catalyst to oil ratios may be of the order of about 2 to 8 parts of catalyst by weight per part of oil charged to the viscosity-breaking zone. The oil space velocity may be somewhat higher than that involved in the conversion zone. When catalyst is recycled from the viscosity-breaking zone to the treating zone, then the catalyst to oil ratio in the viscosity breaking zone may be of the order of about 3 to 12 parts by weight of catalyst per part of oil charged. This recycling procedure is desirable in many operations because of the fact that it permits a further reduction in the inlet temperature of the catalyst to the viscosity-breaking zone by virtue of the higher rate of total catalyst throughput. In general it is desirable to so control the viscosity-breaking reaction that while the liquid charge is substantially entirely vaporized by the time it leaves the viscosity-breaking zone, the gaseous viscosity-broken fraction does not contain more than about 15% liquid volume of 410° F. E. P. gasoline and preferably less than about 8% by volume thereof. In its broader aspects, however, operations outside of this range are contemplated to be within the scope of this invention.

In the treating zone the operating conditions are subject to wider variation due to the number of different types of treating reactions which may be conducted therein. In general oil space velocities may vary from about 0.5 to 20 volumes of oil charge (measured as a liquid at 60° F.) per volume of catalyst within the treating zone (measured as a compact mass). The catalyst to oil ratio may vary from about 0.5 to 10 parts by weight of catalyst per part by weight of hydrocarbon vapor charge. The catalyst may enter the treating zones at temperature within the range about 300° F.–1000° F. and may be withdrawn therefrom at temperatures within the range about 950° F. to 1150° F. The temperature of introduction of the gaseous hydrocarbon reactant will depend upon the catalyst to oil ratio, and the nature of the reactant and reaction involved. Where the reaction involved is exothermic less preheating of the gaseous reactant

charge to the treating zone is required than where the reaction is mildly endothermic. In general the gaseous reactant should be preheated to a temperature which will permit accomplishment of the desired treatment of said reactant while at the same time effecting the desired amount of heating of the catalyst to render it suitable for introduction into the viscosity-breaking zone.

In the catalyst regeneration zone the catalyst should be maintained at a temperature high enough to permit contaminant burning at a practical rate. This minimum required temperature is within the range of about 700–900° F. depending upon the stage of the regeneration and upon the particular contaminant involved. The catalyst also should be controlled below a temperature which would cause substantial permanent impairment of its catalytic effectiveness. The heat damaging temperature varies depending upon the type of contact material involved, being of the order of 1200° F. for natural and treated clays and of the order of 1400° F. to 1500° F. for certain synthetic silica, alumina or silica and alumina adsorbents.

In a typical operation of the system shown in Figure 1, a mid continent petroleum crude residuum containing substantially no material boiling below about 900° F. may be heated in heater 16 to about 825° F. and then introduced into the upper section of viscosity-breaking chamber 11, to contact used contaminant bearing catalyst introduced at about 1030° F. The catalyst to oil ratio in the viscosity-breaking zone may be about 5.0 parts by weight of catalyst per part of oil. The space velocity may be controlled so that the motor gasoline content of the viscosity-broken products is less than about 8% by volume (liquid basis). The catalyst employed in this example is a porous superfiltrol type clay adsorbent formed into particles falling within the range about 4–16 mesh by Tyler standard screen analysis. The viscosity-broken vaporized charge may be withdrawn from zone 11 at about 900° F. at which temperature it is introduced into the upper section of convertor 12. Here it meets a hot freshly regenerated catalyst containing only of the order of about 0.5% by weight carbon and entering at a temperature of about 990° F. The catalyst to oil ratio in zone 12 in this example may be about 5 parts by weight of catalyst per one part of oil charged. The oil space velocity may be about 1.0 volumes of oil per hour per volume of catalyst in the conversion zone. The catalyst may pass from zone 12 to treating zone 11 at about 930° F. The gaseous products from zone 12 may be fractionated in fractionator 15 to provide a fraction containing some dry gas and also hydrocarbons boiling to a point just short of about 600° F. This fraction may be vaporized and heated in heater 16 to a temperature of the order of about 1050–1100° F. at which temperature it is introduced into the lower section of treating zone 14. A reforming of the hydrocarbon occurs resulting in a higher yield of motor gasoline having a higher anti-knock rating than present in the charge to zone 14. The product from treater 14 is fractionated so as to obtain a cycle cut boiling within the range about 420 to 550° F. which fraction is recycled at inlet 61. The recycle ratio may be of the order of 2 parts recycle returned at 61 to one part fraction from fractionator 15. The catalyst to oil ratio in zone 12 may be of the order of 2–3 parts by weight catalyst per part of oil charge. The catalyst leaves treater 14 at about 1030° F. at which temperature it is introduced to the vaporizer 11. The contaminant bearing catalyst is withdrawn from vaporizer 11 at about 900° F. and passed to regenerator 13 wherein the carbonaceous deposits are burned with air at temperatures below 1200° F.

It should be understood that the details of apparatus design and of operating conditions and of application of the method of this invention given hereinabove are intended as exemplary and should not be construed as limiting the scope of this invention except as it may be limited by the following claims.

I claim:

1. In a continuous cyclic process wherein finely divided contact material is moved through a conversion zone wherein it is contacted with gaseous hydrocarbon oil charge to effect the conversion thereof to lower boiling products and causing deposition of a carbonaceous contaminant on said contact material and through a regeneration zone wherein said contaminant is burned off of said contact material, the method of preparing gaseous hydrocarbon oil charge for said conversion zone which comprises: effecting separation of said lower boiling products from said conversion zone from the used contact material and passing the used contact material through a separate treating zone, contacting said used contact material in said treating zone with suitable heated gaseous hydrocarbon requiring treatment so as to effect the treatment of said suitable gaseous hydrocarbon and at the same time an increase in the temperature of the used contact material to a temperature substantially above its temperature as withdrawn from said conversion zone, effecting a substantial separation of the treated gaseous hydrocarbons and the used heated contact material, passing the used heated contact material through a separate vaporizing zone, contacting a liquid hydrocarbon charge with said used heated contact material in said vaporizing zone to effect the transformation of said liquid charge to said gaseous hydrocarbon oil charge for said conversion zone, effecting the separation of said gaseous charge from said contact material and passing said gaseous hydrocarbon charge into said conversion zone and passing separated used contact material to said regeneration zone.

2. In a continuous cyclic process wherein finely divided contact material is moved through a conversion zone wherein it is contacted by a hydrocarbon oil charge in vapor form to effect conversion of said oil to lower boiling products whereby a carbonaceous contaminant is deposited upon the contact material and through a regeneration zone wherein it is contacted with a combustion supporting gas to burn off said contaminant, the method which comprises: effecting separation of said lower boiling products from said conversion zone from said used contact material and passing the used contact material through a separate treating zone, heating a suitable hydrocarbon stream boiling substantially below said hydrocarbon oil charge to a temperature substantially above that of the said used contact material as introduced into said treating zone and contacting said heated hydrocarbon stream with said used contact material in said treating zone to effect a treatment of said hydrocarbons and to effect a rise in the temperature of said contact material to a level substantially above the level at which it is introduced into said treating zone, effecting a substantial separation of the treated contact material from said treated hy-

drocarbons and passing the used heated contact material through a confined vaporizing zone, contacting said contact material in said vaporizing zone with a high boiling difficultly vaporizable oil to effect conversion thereof to said hydrocarbon oil charge in vapor form for said conversion zone, effecting a separation of said hydrocarbon oil charge in vapor form from said contact material, passing said hydrocarbon oil charge in vapor form to said conversion zone, passing the contact material separated therefrom through said regeneration zone, and returning the regenerated contact material to said conversion zone.

3. In a continuous cyclic process wherein finely divided contact material is moved through a conversion zone wherein it is contacted by a hydrocarbon oil charge in vapor form to effect conversion of said oil to lower boiling products whereby a carbonaceous contaminant is deposited upon the contact material and through a regeneration zone wherein it is contacted with a combustion supporting gas to burn off said contaminant, the method which comprises: passing the used contact material from said conversion zone through a separate treating zone while contacting it therein with a heated hydrocarbon fraction boiling substantially below said hydrocarbon oil charge and while effecting a rise of its temperature therein to a level substantially above the temperature of said contact material as withdrawn from said conversion zone, effecting separation of the treated hydrocarbon fraction from the used, heated contact material, passing the used heated contact material through a separate vaporization zone, introducing a suitable liquid hydrocarbon charge into contact with said used, heated contact material in said vaporization zone to effect its transformation to said hydrocarbon oil charge in vapor form for said conversion zone and passing said hydrocarbon oil charge in vapor form to said conversion zone.

4. A method for conversion of high boiling liquid hydrocarbons to lower boiling gasoline containing products which comprises: contacting said high boiling liquid charge in a confined conversion zone with a contaminant bearing particle-form contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid charge to a gaseous hydrocarbon charge, effecting separation of said gaseous charge from said spent contaminant bearing contact material, passing spent contact material through a separate regeneration zone while contacting it therein at controlled elevated temperatures with a combustion supporting gas to burn off said contaminant from said contact material, passing the contact material substantially freed of carbonaceous contaminant into a second confined conversion zone at a temperature suitable for supporting the conversion of said gaseous hydrocarbon charge to a lower boiling gaseous gasoline containing product, passing said gaseous hydrocarbon charge from said first named conversion zone into contact with said contact material in said second conversion zone to effect said conversion thereof, effecting substantial separation of the used contact material upon which a carbonaceous contaminant has been deposited during said conversion from said gaseous products, passing said used contact material to a separate treating zone, contacting said contact material in said treating zone with a heated hydrocarbon fraction boiling substantially below said gaseous hydrocarbon charge to effect a treatment of said fraction and to effect an increase in the contact material temperature to a level materially above its level as withdrawn from said conversion zone and passing said used heated contact material to said first named conversion zone.

5. A method for conversion of high boiling liquid hydrocarbons to lower boiling gasoline containing products which comprises: contacting said high boiling liquid charge in a confined partial conversion zone with a particle-form porous catalyst bearing a carbonaceous contaminant deposit which catalyst is introduced into said zone at a temperature suitable for supporting the conversion of said high boiling liquid charge to partially converted lower boiling hydrocarbons, effecting substantial separation of said catalyst from said partially converted lower boiling vaporous hydrocarbons, passing said catalyst through a separate regeneration zone while contacting it therein at temperatures below a heat damaging level with a combustion supporting gas to burn off said contaminant, thereby regenerating said catalyst, passing the regenerated catalyst through a confined conversion zone at a temperature suitable for supporting the conversion of said partially converted lower boiling hydrocarbons to a lower boiling gasoline containing hydrocarbon product, passing said partially converted lower boiling hydrocarbons in the vapor state from said partial conversion zone into contact with said catalyst in said conversion zone to effect said conversion thereof, effecting separation of said lower boiling product from the used catalyst upon which a carbonaceous contaminant has been deposited during said hydrocarbon conversion, passing the used contact material through a separate treating zone, heating a suitable hydrocarbon fraction boiling substantially below said partially converted hydrocarbons and passing it into contact with said used catalyst in said treating zone to effect a treatment of said fraction and to effect a rise in the temperature of said catalyst to a level which is substantially above the level at which said used catalyst is removed from said conversion zone and which is suitable for its introduction to said partial conversion zone, effecting a substantial separation of the used, heated catalyst from the treated hydrocarbon fraction and passing said catalyst to said partial conversion zone.

6. A process for conversion of a high boiling liquid petroleum fraction to lower boiling gasoline containing hydrocarbons which comprises: introducing a heated high boiling liquid petroleum fraction into contact with a substantially compact column of hot contaminant bearing catalyst particles maintained within a confined partial conversion zone, said catalyst particles being introduced into said zone at a temperature sufficient to supply the heat required for conversion of said high boiling liquid petroleum fraction to lower boiling partially converted gaseous hydrocarbons, withdrawing said partially converted gaseous hydrocarbons from said partial conversion zone and passing said gaseous hydrocarbons through an elongated confined conversion zone concurrently to the flow of a substantially compact column of downwardly moving regenerated particles of catalyst introduced into said zone at a suitable conversion supporting temperature to effect the desired conversion of said gaseous hydrocarbons to lower boiling gasoline containing hydrocarbon products, withdrawing said lower boiling hydrocarbon products from said conversion zone, separately withdrawing

used contaminant bearing catalyst from said conversion zone and passing it as a substantially compact column through a separate second conversion zone, heating a suitable hydrocarbon fraction boiling substantially below the boiling range of said partially converted gaseous hydrocarbons to a temperature substantially above that at which said catalyst is withdrawn from said conversion zone, passing said heated hydrocarbon fraction into contact with said catalyst in said second conversion zone to effect a conversion of said hydrocarbon fraction to gasoline containing products, and to effect a rise in the catalyst temperature to a level substantially above that at which it was withdrawn from said conversion zone, withdrawing the converted gasoline containing products from said second conversion zone and passing the used, heated catalyst from said second conversion zone to said partial conversion zone as the hot catalyst supply thereto, withdrawing catalyst bearing additional contaminant from said partial conversion zone, passing a portion of said catalyst withdrawn from said partial conversion zone to a final regeneration zone while contacting it therein with oxygen containing gas to burn off substantially all of said contaminant deposited thereon and while removing the sufficient heat from said catalyst within said regeneration zone to at least control its temperature below a heat damaging level, withdrawing regenerated catalyst from said regeneration zone and introducing it into said conversion zone at a suitable conversion temperature as aforesaid and passing the remaining portion of said catalyst withdrawn from said partial conversion zone back to said separate second conversion zone.

7. A process for catalytic conversion of a high boiling liquid hydrocarbon charge to lower boiling, gasoline containing gaseous products which method comprises: passing particle-form solid contact material at suitable hydrocarbon conversion temperature through an elongated conversion zone as a substantially compact column of downwardly moving particles, passing gaseous hydrocarbon charge through said conversion zone in contact with said contact material to effect conversion of said gaseous charge to lower boiling gasoline containing hydrocarbon products, withdrawing said lower boiling products from said conversion zone, withdrawing used contact material bearing a carbonaceous contaminant from said conversion zone and subjecting said used contact material to contact with a heated gaseous hydrocarbon fraction boiling substantially below said gaseous hydrocarbon charge to said conversion zone to effect a treatment of said fraction to provide a valuable gasoline containing product and to effect a rise in contact material temperature to a level substantially above that at which said contact material was withdrawn from said conversion zone, effecting a separation of the heated contact material from the treated gaseous products, passing the heated contact material bearing a carbonaceous contaminant deposit through an elongated vaporizing zone as a substantially compact column of downwardly moving particles, introducing a heated high boiling liquid hydrocarbon into contact with said column of heated contact material within said vaporizing zone to effect conversion thereof to gaseous hydrocarbons boiling mostly above gasoline, passing said gaseous hydrocarbons to said conversion zone as said gaseous hydrocarbon charge thereto, withdrawing spent contaminant bearing contact material from said vaporizing zone, effecting the regeneration of said spent contact material by substantially burning off said contaminant at controlled temperature below a level which would cause substantial heat damage to said contact material and passing the regenerated contact material to said conversion zone.

8. The process for conversion of residuum petroleum fractions to valuable lower boiling products which comprises: passing a liquid residuum petroleum fraction into contact with a stream of hot contaminant bearing contact material particles within a confined partial conversion zone to convert said liquid residuum to lower boiling partially converted gaseous hydrocarbons, said contact material being introduced into said zone at a temperature sufficiently high to support said conversion without cooling below the condensation temperature of said partially converted gaseous hydrocarbons, withdrawing said gaseous hydrocarbons from said zone and passing them into an elongated, confined conversion zone into contact with a stream of regenerated contact material particles introduced into said zone at a temperature suitable to support the completion of the conversion of said gaseous hydrocarbon products, withdrawing gaseous conversion products from said conversion zone and withdrawing contaminant bearing contact material therefrom, passing said contaminant bearing contact material through a separate confined reaction zone, contacting said contact material in said separate reaction zone with heated gaseous hydrocarbons boiling substantially below the boiling range of said partially converted gaseous hydrocarbons charged to said conversion zone to effect a conversion of said gaseous hydrocarbons to desired products while at the same time heating said contact material to a temperature which is substantially above that temperature at which it was withdrawn from said conversion zone and which is a suitable inlet temperature to said partial conversion zone, passing the contaminant bearing, heated contact material into said partial conversion zone, withdrawing spent contaminant bearing contact material from said partial conversion zone after contact with said liquid residuum fraction as aforesaid, recycling a portion of said spent contact material from said partial conversion zone to said separate reaction zone, passing the remainder of said spent contact material from said partial conversion zone to a confined regeneration zone, passing a combustion supporting gas through said regeneration zone in contact with said contact material to burn off substantially all the contaminent therefrom, withdrawing heat from said regeneration zone to control the temperature of said contact material below a heat damaging level and passing regenerated contact material from said regeneration zone to said conversion zone as said stream of regenerated contact material introduced thereinto.

9. A method according to claim 6 characterized in that the weight ratio of catalyst to hydrocarbon throughput in said conversion zone is controlled within the range 2 to 8 parts of catalyst to 1 part of hydrocarbon and the weight ratio of catalyst to hydrocarbon throughput in said partial conversion zone is controlled within the range about 2 to 12 parts of catalyst to 1 part of hydrocarbon.

10. In a continuous cyclic process wherein finely divided contact material is moved through a con-

version zone wherein it is contacted with a hydrocarbon oil charge in gaseous form to effect conversion thereof to lower boiling products and causing deposition of a carbonaceous contaminant on said contact material and through a regeneration zone wherein said contaminant is burned off of said contact material, the method which comprises effecting separation of said lower boiling products from the used contact material, passing the used contact material through a second conversion zone, contacting said used contact material in said second conversion zone with gaseous hydrocarbons boiling below about 600° F. under conditions controlled to effect conversion of said gaseous hydrocarbons to desired products while at the same time effecting a rise in the contact material temperature to a level substantially above its temperature as withdrawn from said first conversion zone, effecting a substantial separation of the used contact material from the converted gaseous hydrocarbons from said second conversion zone, passing the used, heated contact material through a viscosity-breaking zone, contacting said used heated contact material in said viscosity-breaking zone with a high boiling liquid charge which is difficultly vaporizable to effect conversion of said liquid charge to a lower boiling gaseous hydrocarbon oil charge, effecting the separation of said lower boiling gaseous hydrocarbon oil charge from the used contact material and passing it to said first conversion zone as the gaseous hydrocarbon oil charge thereto.

11. A combination catalytic process for catalytically viscosity-breaking cracking and reforming of hydrocarbon oil fractions which comprises: passing a suitable particle-form adsorbent contact material at suitable hydrocarbon cracking temperature through an elongated conversion zone as a substantially compact column of downwardly moving particles, passing gaseous hydrocarbon charge through said conversion zone in contact with said contact material to effect conversion of said gaseous charge to lower boiling gasoline containing hydrocarbon products, withdrawing said lower boiling products from said conversion zone, withdrawing used contact material bearing a carbonaceous contaminant from said conversion zone and passing it through a confined reforming zone as a substantially compact column, heating a hydrocarbon oil fraction boiling within gasoline-kerosene boiling range to a temperature substantially above the temperature of contact material withdrawal from said conversion zone, passing said heated hydrocarbon oil fraction into contact with said contact material column in said reforming zone under such conditions as to effect the reforming of said fraction to gaseous gasoline containing products and the heating of said contact material to a level substantially above the temperature of its withdrawal from said conversion zone, withdrawing the gaseous reformed products from said reforming zone, withdrawing used, heated contact material from said reforming zone substantially separately from said gaseous reforming products and passing it through an elongated partial conversion zone as a substantially compact column of downwardly moving particles, introducing heated high boiling liquid hydrocarbon charge into contact with said heated contact material within said partial conversion zone to effect conversion thereof to partially converted gaseous hydrocarbons, passing said gaseous hydrocarbons to said conversion zone as said gaseous hydrocarbon charge thereto, withdrawing spent contaminant bearing contact material from said partial conversion zone and passing said spent contact material as a substantially compact column through an elongated regeneration zone, passing combustion supporting gas into contact with said contact material to burn off substantially all of the carbonaceous contaminant from said contact material, passing a heat exchange fluid into indirect heat transfer relationship with said contact material within said regeneration zone to control the temperature of said contact material below a heat damaging level and passing regenerated contact material from said regeneration zone to said conversion zone.

12. A hydrocarbon conversion process which comprises: contacting a high boiling liquid charge which is unvaporizable without substantial decomposition to lower boiling hydrocarbons in a confined conversion zone with a contaminant bearing particle-form contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid charge to a gaseous hydrocarbon charge, effecting separation of said gaseous charge from said spent contaminant bearing contact material, passing spent contact material through a separate regeneration zone while contacting it therein at controlled elevated temperature with a combustion supporting gas to burn off said contaminant from said contact material, passing the contact material substantially freed of carbonaceous contaminant into a second confined conversion zone at a temperature suitable for supporting the conversion of said gaseous hydrocarbon charge to a lower boiling gaseous gasoline containing product, passing said gaseous hydrocarbon charge from said first named conversion zone into contact with said contact material in said second conversion zone to effect said conversion thereof, effecting substantial separation of the used contact material upon which a carbonaceous contaminant has been deposited during said conversion from said gaseous products, passing said used contact material to a separate reaction zone, passing a suitable heated hydrocarbon fraction boiling below about 600° F. in admixture with a controlled amount of oxygen into contact with said contact material in said separate reaction zone to effect a controlled oxidation of said fraction to form gaseous oxygen containing products and to heat said contact material to a temperature which is substantially above the temperature at which it is withdrawn from said second conversion zone and which is a suitable inlet temperature to said first named conversion zone, effecting a substantial separation of the gaseous products formed in said separate reaction zone from the used contact material passing the used, heated contact material from said separate reaction zone to said first named conversion zone as the contact material charge thereto.

13. A method for conversion of high boiling liquid hydrocarbons to lower boiling gasoline containing products which comprises: contacting said high boiling liquid charge in a confined conversion zone with a contaminant bearing particle-form contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid charge to a gaseous hydrocarbon charge, effecting separation of said gaseous charge from said spent contaminant bearing contact material, passing spent contact material

through a separate regeneration zone while contacting it therein at controlled elevated temperature with a combustion supporting gas to burn off said contaminant from said contact material, passing the contact material substantially freed of carbonaceous contaminant into a second confined conversion zone at a temperature suitable for supporting the conversion of said gaseous hydrocarbon charge to a lower boiling gaseous gasoline containing product, passing said contact material downwardly through said second conversion zone as a substantially compact column of downwardly moving particles, introducing said gaseous hydrocarbon charge formed in said first conversion zone into the lower section of said second conversion zone and passing it upwardly through said column so as to become converted to lower boiling gaseous products, withdrawing the gaseous products from the upper section of said second conversion zone and without substantial cooling introducing said gaseous products into the lower section of a third conversion zone, upwardly passing said hydrocarbons through said third conversion zone, passing the used contact material from the lower section of said second conversion zone into the upper section of said third conversion zone and passing it downwardly through said third conversion zone as a substantially compact column countercurrently to the upwardly flowing gaseous hydrocarbons, withdrawing gaseous hydrocarbon products from the upper section of said third conversion zone, withdrawing used contact material which has been heated by said gaseous hydrocarbons from the lower section of said third conversion zone, and passing said used, heated contact material to said first conversion zone as the contact material charge thereto.

14. A method for conversion of high boiling liquid hydrocarbons to lower boiling gasoline containing products which comprises: contacting said high boiling liquid charge in a confined conversion zone with a contaminant bearing particle-form contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid charge to a gaseous hydrocarbon charge, effecting separation of said gaseous charge from said spent contaminant bearing contact material, passing spent contact material through a separate regeneration zone while contacting it therein at controlled elevated temperatures with a combustion supporting gas to burn off said contaminant from said contact material, passing the contact material substantially freed of carbonaceous contaminant into a second confined conversion zone at a temperature suitable for supporting the conversion of said gaseous hydrocarbon charge to a lower boiling gaseous gasoline containing product, passing said gaseous hydrocarbon charge from said first named conversion zone into contact with said contact material in said second conversion zone to effect said conversion thereof, effecting substantial separation of the used contact material upon which a carbonaceous contaminant has been deposited during said conversion from said gaseous products, passing said used contact material to a separate treating zone, heating said gaseous products materially above the temperature of their withdrawal from said second conversion zone and passing the heated gaseous products into contact with said used contact material in said treating zone to effect a treatment of said gaseous products and to effect an increase in the contact material temperature to a level materially above its level as withdrawn from said second conversion zone, effecting a substantial separation of the treated gaseous products from the used, heated contact material and passing said used, heated contact material to said first named conversion zone.

15. A method for conversion of high boiling liquid hydrocarbons to lower boiling gasoline containing products which comprises: contacting said high boiling liquid charge in a confined conversion zone with a contaminant bearing particle-form contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid charge to a gaseous hydrocarbon charge, effecting separation of said gaseous charge from said spent contaminant bearing contact material, passing spent contact material through a separate regeneration zone while contacting it therein at controlled elevated temperatures with a combustion supporting gas to burn off said contaminant from said contact material, passing the contact material substantially freed of carbonaceous contaminant into a second confined conversion zone at a temperature suitable for supporting the conversion of said gaseous hydrocarbon charge to a lower boiling gaseous gasoline containing product, passing said gaseous hydrocarbon charge from said first named conversion zone into contact with said contact material in said second conversion zone to effect said conversion thereof, effecting substantial separation of the used contact material upon which a carbonaceous contaminant has been deposited during said conversion from said gaseous products, passing said used contact material through a separate treating zone, fractionating from said gaseous products a fraction boiling below about 600° F., heating said fraction to a temperature substantially above the temperature at which said contact material is withdrawn from said second conversion zone, passing said heated fraction in vapor form into contact with said used contact material in said treating zone to effect a treatment of said fraction and to effect an increase in the contact material temperature to a level materially above its level as withdrawn from said conversion zone and passing said used heated contact material to said first named conversion zone.

16. A process for conversion of a high boiling liquid petroleum fraction to lower boiling gasoline containing hydrocarbons which comprises: introducing a heated high boiling liquid petroleum fraction into contact with a substantially compact column of hot contaminant bearing catalyst maintained within a confined partial conversion zone, said particles being introduced into said zone at a temperature sufficient to supply the heat required for conversion of said high boiling liquid petroleum fraction to lower boiling partially converted gaseous hydrocarbons, withdrawing said partially converted gaseous hydrocarbons from said partial conversion zone and passing said gaseous hydrocarbons through an elongated confined conversion zone concurrently to the flow of a substantially compact column of downwardly moving regenerated particles of catalyst introduced into said zone at a suitable conversion supporting temperature to effect the desired conversion of said gaseous hydrocarbons to lower boiling gasoline containing hydrocarbon products, withdrawing said lower boiling hydrocarbon products from said conversion zone, separately withdrawing used contaminant bearing catalyst from said conversion zone and pass-

ing it as a substantially compact column through a separate reforming zone, fractionating a fraction boiling within the gasoline-kerosene boiling range from said gaseous gasoline containing products from said conversion zone, heating said fraction to a temperature substantially above the temperature of catalyst withdrawal from said conversion zone, introducing said heated fraction in gaseous form into the lower section of said reforming zone and passing it upwardly through said column of catalyst therein, to effect a reforming of said fraction and a heating of said catalyst to a temperature substantially above that at which it was withdrawn from said conversion zone, withdrawing the reformed gaseous fraction from the upper section of said reforming zone and withdrawing used, heated catalyst from the lower section thereof, passing said used, heated catalyst into said partial conversion zone as aforesaid, withdrawing catalyst bearing additional contaminant from said partial conversion zone, passing said catalyst to a final regeneration zone while contacting it therein with oxygen containing gas to burn off substantially all of said contaminant deposited thereon and while removing sufficient heat from said catalyst within said regeneration zone to at least control its temperature below a heat damaging level, withdrawing regenerated catalyst from said regeneration zone and introducing it into said conversion zone at a suitable conversion temperature as aforesaid.

17. A process for conversion of liquid petroleum residuum fractions to gasoline containing products which comprises: introducing a heated contaminant bearing particle-form adsorbent catalyst into the upper section of a confined viscosity-breaking zone and passing it downwardly therethrough as a substantially compact column of gravitating particles, introducing a heated liquid petroleum residuum fraction into said column within the upper section of said viscosity-breaking zone, passing said residuum downwardly within said column to effect its conversion to lower boiling gaseous hydrocarbons containing less than about 15 percent by weight gasoline, the heat for said conversion being supplied by said incoming heated catalyst, withdrawing said lower boiling gaseous hydrocarbons from the lower section of said viscosity-breaking zone, and passing said gaseous hydrocarbons through an elongated confined conversion zone concurrently to the flow of a substantially compact column of downwardly moving regenerated particles of catalyst introduced into said zone at a suitable conversion supporting temperature to effect the desired conversion of said gaseous hydrocarbons to lower boiling gasoline containing hydrocarbon products, withdrawing said lower boiling hydrocarbon products from said conversion zone, separately withdrawing used contaminant bearing catalyst from said conversion zone and passing it as a substantially compact column downwardly through a reforming zone, separating out from said gasoline containing products a gasoline fraction, heating said gasoline fraction and introducing it in the vaporized state into the lower section of said reforming zone, passing said gasoline fraction upwardly through the column of catalyst in said reforming zone to effect a reforming of said gasoline and to heat said catalyst to a temperature suitable for its introduction to said viscosity-breaking zone, the heat for said reforming and the heating of the catalyst being provided as preheat in the gasoline fraction as introduced to said reforming zone, withdrawing reformed products from the upper section of said reforming zone, withdrawing used, heated catalyst from the lower section thereof and passing it to said viscosity-breaking zone as aforesaid, withdrawing catalyst bearing additional contaminant from said viscosity-breaking zone, passing at least a portion of said catalyst withdrawn from said viscosity-breaking zone to a regeneration zone while contacting it therein with oxygen containing gas to burn off substantially all of said contaminant deposited thereon and while removing sufficient heat from said catalyst within said regeneration zone to at least control its temperature below a heat damaging level, withdrawing regenerated catalyst from said regeneration zone and introducing it into said conversion zone at a suitable conversion temperature as aforesaid.

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