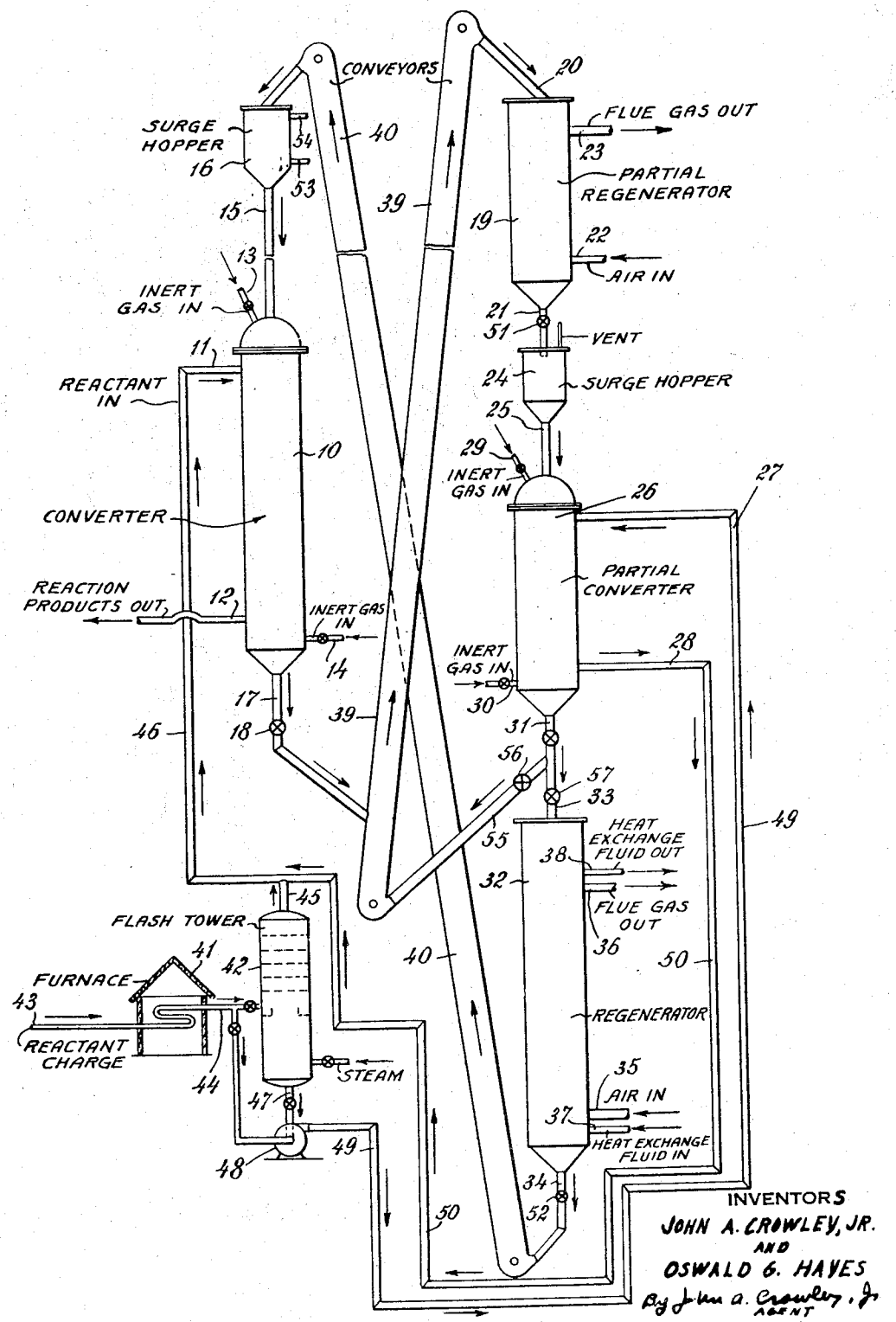
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HYDROCARBON CONVERSION PROCESS

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HYDROCARBON CONVERSION PROCESS

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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 gasoline boiling range. The invention is particularly concerned with a method for conversion of high boiling liquid hydrocarbon charges to lower boiling hydrocarbons in the presence of a substantially compact column of moving particle form contact mass material. A recently developed and important form of such a conversion process has taken the form of one wherein particle form solid contact mass material is passed cyclically through a conversion zone wherein it flows as a substantially compact column and is contacted with hydrocarbons in the gaseous phase to effect the conversion thereof and through a regeneration zone wherein it is contacted with a combustion supporting gas acting to burn off of the contact material the carbonaceous contaminant deposited thereon during the hydrocarbon conversion. The contact material may take the form of natural or treated clays such as fuller's earth and Super Filtrol or bauxites, or alumina or synthetic associations of silica, alumina, silica and alumina to which may be added small percentages of other materials such as certain metallic oxides. The contact material particles may fall within the size range of about 4 to 100 mesh and preferably 4 to 8 mesh as measured by standard Tyler screen analysis. Such conversion processes have been heretofore generally limited to the conversion of such petroleum charging stocks as may be completely vaporized at the desired conversion conditions, for example, it is well known that gas oils boiling within the range about 450° F. to 750° F., upon being contacted in the gaseous phase with particle form adsorbent material at temperatures of the order of 800° F. to 950° F., and usually superatmospheric pressure, may be converted to lower boiling hydrocarbons containing a substantial percentage of material boiling within the gasoline boiling range. Many otherwise acceptable charging stocks such as heavy fuel oils and reduced crudes boil substantially above the normally desirable conversion temperatures and attempts to vaporize such high boiling charging stocks before charging to a catalytic conversion zone results in undesirable pyrolytic cracking and excessive coke and non-condensible gas formation. On the other hand, if such high boiling charge stocks are charged to a catalytic conversion zone in the liquid phase, then the heat required for vaporization as well as that required for conversion must be supplied by introducing

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the active contact material into the conversion zone at a temperature far above the suitable conversion temperature. Such operation means the contacting of the hydrocarbon charge with fresh active contact material at temperatures far above the suitable conversion level, thereby causing excessive conversion with resultant excessive formation of coke and non-condensible gas and low yields of gasoline of unsatisfactory quality.

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

Another object is the provision of a continuous cyclic process for conversion of high boiling liquid petroleum fractions to lower boiling gasoline containing gaseous hydrocarbon products in the presence of a substantially compact column of moving contact material particles and for combustion regeneration of said contact material, wherein the heat required for said conversion is supplied from said combustion regeneration without the necessity of employing excessive catalyst to oil ratios and temperatures for the hydrocarbon conversion.

Another object is the provision of a method whereby petroleum fraction containing hydrocarbons boiling both below and above the desired average catalytic conversion temperature therefore may be converted to valuable lower boiling gaseous hydrocarbon products entirely in the presence of a moving mass of contact material while maintaining suitable conversion temperatures and a low catalyst to oil ratio during said conversion.

A specific object of this invention is the provision in a continuous cyclic catalytic process for conversion of hydrocarbons of a new and practical method for converting a high boiling liquid charge to a suitable gaseous convertor charge.

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 invention may be better understood by reference to the single drawing attached hereto which shows in highly diagrammatic form an apparatus arrangement adapted for the method of this invention.

Turning now to the attached drawing, there is shown a convertor 10 which may be of any suitable cross-sectional shape but which is preferably cylindrical in shape. The convertor is provided with a solid feed leg 15 at its upper end for supply of catalyst thereinto from the surge hopper 16, and a drain conduit 17 bearing a flow control valve 18 at its lower end. An inlet 11 for gaseous reactants is provided near the upper end of convertor 10 and a reactant outlet 12 is provided near the lower end thereof. Inlets 13 and 14 are provided at the upper and near the lower ends respectively of the convertor for admission of inert seal gas. Also provided is a partial regenerator 19 having a solid inlet 20 at its upper end, a solid outlet 21 at its lower end, a gas inlet 22 near its lower end and a gas outlet 23 near its upper end. The solid drain conduit 21 from partial regenerator 19 connects into a surge hopper 24 located therebelow and the surge hopper 24 is in solid flow communication through conduit 25 with a partial converter 26 located below the hopper 24. The vessel 26 is provided with reactant inlet 27 near its upper end, reactant outlet 28 near its lower end, seal gas inlets 29 and 30 near its upper and lower ends respectively, and solid outlet conduit 31 at its lower end. Below the partial convertor is positioned a regenerator 32 having solid inlet 33 at its upper end, solid outlet 34 at its lower end, gas inlet 35 near its lower end and gas outlet 36 near its upper end. Also provided are inlet 37 and outlet 38 for flow of heat exchange fluid, said inlet and outlet connecting into properly distributed heat transfer tubes within the regenerator (not shown). A conveyor 39 is provided to transfer contact material discharged from the convertor 10 to the partial regenerator 19. A conveyor 40 is provided for transfer of solid material drained from the regenerator 32 to the convertor surge hopper 16. These conveyors may be of any suitable construction adapted for conveying high temperature solid particles, for example a continuous bucket elevator. Also provided is a charging stock heating furnace 41 which may be of conventional construction and a gas-liquid separating or flash tower 42 which may be similarly of conventional construction.

As an example of the operation of this invention, the conversion of a crude petroleum fraction from which gasoline and naphtha has been topped and from which a heavy tar cut may or may not have been stripped may be considered. Such a petroleum fraction may contain hydrocarbons boiling as low as 450° F. and may also contain a substantial proportion of high boiling liquid hydrocarbons boiling substantially above the desirable catalytic conversion temperature, for example, material boiling above about 850° F. to 950° F. According to the method of this invention, such a broad boiling petroleum fraction is passed through coil 43 in furnace 41 wherein it is heated to a suitable temperature, generally within

the range 600° F. to 900° F., so as to accomplish vaporization of at least most of the hydrocarbons boiling below the desired catalytic conversion temperature. The heated hydrocarbons pass through conduit 44 into flash or separating tower 42 wherein the vaporized material is separated from the liquid. The vaporized gaseous hydrocarbons are withdrawn from tower 42 through conduit 45 and then passed via conduit 46 and reactant inlet 11 into the convertor 10. The high boiling liquid fraction of the charge separated in tower 42 is withdrawn therefrom through conduit 47 through which it passes to pump 48 and thence through conduit 49 and reactant inlet 27 into partial convertor 26. The liquid hydrocarbon fraction is uniformly distributed over the cross section of a substantially compact column of particle form catalyst within the upper section of vessel 26 and passes downwardly concurrently with the catalyst so as to be converted into lower boiling partially converted gaseous hydrocarbons. The catalyst introduced into the upper end of partial convertor 26 from surge hopper 24 via feed leg 25 is at a temperature sufficiently high to supply the heat required to convert said high boiling liquid hydrocarbons to lower boiling gaseous hydrocarbons without itself being cooled below a temperature suitable for the conversion or below the boiling temperature of the resulting partially converted hydrocarbons. In order to prevent excessive conversion of the liquid hydrocarbons due to contact with the hot catalyst, the catalyst introduced into partial convertor 26 is partially spent catalyst bearing a substantial contaminant deposit. The partially converted gaseous hydrocarbons are withdrawn from partial convertor 26 through outlet 28 and passed via conduits 50 and 46 and inlet 11 into the convertor 10 along with the separated gaseous hydrocarbons from tower 42. If desired, provision may be made for introduction of the two streams of gaseous hydrocarbons into the convertor through separate outlets and at different levels. The mixed gaseous hydrocarbons within the convertor 10 contact a substantially compact column of downwardly moving catalyst particles so as to effect the conversion of said gaseous hydrocarbons to lower boiling, gasoline containing hydrocarbon products which are withdrawn from the convertor through outlet 12. The hydrocarbon products may be fractionated in conventional equipment, not shown. Inert seal gas such as steam or flue gas is introduced into the upper end of convertor 10 through inlet 13 and into the lower end through inlet 14 so as to prevent escape of hydrocarbons through the catalyst feed leg 15 or drain conduit 17. The seal gas introduced at 14 may also serve as a purge gas to purge gaseous hydrocarbons from the catalyst just prior to the withdrawal of said catalyst from the convertor. Freshly regenerated catalyst is introduced to the convertor 10 from surge hopper 16 via feed leg 15 at a temperature sufficiently high to supply the heat required for the hydrocarbon conversion within the convertor without being cooled in the convertor to a temperature below that at which hydrocarbon conversion proceeds at a practical rate. Spent catalyst, bearing carbonaceous contaminant deposited during the hydrocarbon conversion, is passed from the convertor 10 via conduit 17 and flow control valve 18 to conveyor 39 by which it is conducted to the inlet conduit 20 of the partial regenerator 19. The spent catalyst passes downwardly through the partial regenerator as a substantially com-

pact column at a suitable rate which may be controlled by means of valve 51 on the partial regenerator solid outlet conduit 21. Combustion supporting gas such as air or flue gas mixtures containing controlled percentages of oxygen is introduced into partial regenerator 19 through inlet 22 to contact the spent catalyst therein and to burn off therefrom only part of the contaminant deposit. The amount of contaminant burned from the catalyst in partial regenerator 19 should be at least sufficient to heat the catalyst to a suitable inlet temperature to the partial convertor 26. If the amount of contaminant burned is in excess of that required to so heat the catalyst, the excess heat may be removed by a heat exchange fluid or by recirculation of cold flue gas with the combustion gas. A suitable catalyst inlet temperature to the partial convertor 26 is one at which the sensible heat content of the catalyst entering the partial convertor 26, above a temperature at which the gaseous hydrocarbon products formed in said partial convertor will condense and above the minimum temperature at which the desired hydrocarbon conversion will take place at a practical rate, is sufficient to supply the heat required for conversion of the high boiling liquid hydrocarbon charge to the partial convertor to the partially converted gaseous hydrocarbons withdrawn therefrom. It is in this sense that the term "suitable inlet temperature to the partial conversion zone" is used in claiming this invention. Flue gas is withdrawn from partial regenerator through outlet 23 and partially regenerated catalyst still bearing a substantial contaminant deposit passes from the partial regenerator 19 through conduit 21 to the surge hopper 24. As has been shown hereinabove, the catalyst then passes through the partial conversion vessel 26 wherein additional contaminant is deposited upon the catalyst during the hydrocarbon conversion. The spent catalyst from vessel 26 then passes through outlet 31 and regenerator inlet 33 into the regenerator 32 wherein substantially all of the carbonaceous contaminant is burned by the action of a combustion supporting gas introduced at 35 and withdrawn at 36. An externally cooled heat exchange fluid entering at 37 and leaving at 38 is passed in indirect heat transfer relationship with the catalyst by passage through properly distributed heat transfer tubes within the regenerator. The amount of heat removed by the heat exchange fluid is sufficient to control the regenerating catalyst between a minimum temperature below which rapid combustion will not take place and a maximum temperature above which the catalyst may suffer permanent heat damage. Substantially regenerated catalyst is withdrawn from the bottom of the regenerator 32 through conduit 34 and flow control valve 52 to conveyor 40 by which it is conducted to surge hopper 16, ready for another cycle. The catalyst temperature in the hopper 16 may be adjusted to a suitable convertor inlet temperature by means of a heat exchange fluid introduced to tubes within the hopper 16 through inlet 53 and withdrawn through outlet 54. Alternatively, adjustment of catalyst temperature, if necessary at all, may be accomplished in a special cooling section (not shown) near the bottom of the regenerator 32.

While the use of catalyst containing a substantial contaminant deposit is in many operations sufficient to prevent excessive conversion of liquid hydrocarbons to gas and coke because

of high catalyst temperatures, the operation may be further improved by recycling a certain portion of the catalyst withdrawn from partial convertor 26 back to the partial regenerator 19 from which it flows back again to the partial convertor 26. This may be accomplished by passing a part of the catalyst from partial convertor outlet 31 through conduit 55 to conveyor 39 by which it is conducted along with catalyst from convertor 10 to the partial regenerator 19. The proper proportion of catalyst recycle and catalyst flow to regenerator 32 may be controlled by means of valves 56 and 57 on conduits 55 and 33, respectively. This recycling expedient helps to prevent overconversion of liquid hydrocarbons in vessel 26 in two ways. First, it may provide a heavier average contaminant deposit on the catalyst introduced into partial convertor 26 so as to provide a less active catalyst. Second, it permits substantial increase in the total amount of catalyst passed into and through the partial convertor so that substantially the same amount of heat required for hydrocarbon conversion may be supplied by a large amount of catalyst at a relatively lower temperature rather than by a much smaller amount of catalyst at a necessarily much higher temperature. In this way, the catalyst temperature throughout the partial convertor is maintained closer to the desired conversion temperature than is possible without catalyst recycling.

In many operations the original hydrocarbon charge may be a reduced crude or some other heavy petroleum fraction containing little or no material boiling above the desired average conversion temperature for gaseous hydrocarbons in convertor 10. In such operations the heated high boiling petroleum fraction may pass directly from furnace outlet conduit 44 through conduit 58 to pump 48, and thence through conduit 49 and inlet 27 into the partial convertor 26. It is possible also to charge cold liquid hydrocarbons directly into the upper section of partial convertor 26, but such operation requires higher catalyst temperatures and is usually undesirable for that reason.

It will be understood that while it is important to the method of this invention that the catalyst pass through the conversion, partial regeneration, partial conversion and regeneration zones in the sequence described hereinabove, the exact location of the several vessels or zones and the means of conducting catalyst from one to another may be subject to considerable modification. For example, each of the four principal vessels could be located side by side with provision of additional conveyors or they may be superposed in any desired order provided the proper sequence of catalyst flow is maintained. It will be also understood that the partial regenerator and regenerator may be of substantially different construction than that shown. For example, the regenerator may be of multi-stage construction providing a plurality of superposed burning stages provided with cooling stages between the burning stages or within alternate burning stages.

It is of considerable importance to note that the method of this invention permits conversion of high boiling liquid hydrocarbons to finally converted gasoline containing gaseous hydrocarbons at substantially the same conditions of catalyst to oil ratio, temperature and oil space velocity as is now used for conversion of lower boiling hydrocarbons capable of vaporization at desirable average conversion temperature therefor such as petroleum gas oils. That this is so is readily ap-

parent from the fact that the hydrocarbon charge to the convertor 10 is in the gaseous phase and has undergone substantially no conversion in the absence of a catalyst. The catalyst to oil ratio in the conversion zone may in general fall within the range 1 to 5 parts of catalyst by weight per part of oil passed through the conversion zone. The oil space velocity may fall within the range 0.5 to 10 volumes of oil (measured as a liquid at 60° F.) per hour per volume of catalyst within the conversion zone. The catalyst inlet temperature to the conversion zone may be of the order of 900° F.–1100° F. and the outlet temperature of the order of 800° F. to 1000° F. depending upon the particular operation involved.

The operating conditions within the partial conversion zone are also subject to considerable variation depending upon the particular operation involved. When the original hydrocarbon charge is substantially all material incapable of vaporization at the desirable convertor temperature, and when there is no catalyst recycle from the partial convertor to the partial regenerator, it will be apparent that the catalyst to oil ratios maintained in the partial conversion zone will be of the same order as those in the conversion zone, while the oil space velocity and catalyst inlet temperature may be somewhat higher. On the other hand, when the preferable procedure of catalyst recycle is followed, the catalyst to oil ratios in the partial conversion zone may be of the order of about 2.5 to 7.0 parts by weight catalyst throughput per part of oil throughput. The catalyst inlet temperature to the partial conversion zone under such conditions 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.

Because of the use of concurrent flow of catalyst and hydrocarbons in both the conversion and partial conversion zone, the hydrocarbon outlet temperature from said zones, will approximate the catalyst outlet temperature therefrom. It will be apparent that the concurrent flow operation limits the amount of heat carried away from the conversion and partial conversion zones in the efficient hydrocarbon streams to a minimum thereby permitting lower catalyst to oil ratios and lower catalyst inlet temperatures than would be otherwise possible.

The range of catalyst temperatures in the partial regeneration zone are for the most part controlled by the convertor outlet temperature and the partial convertor inlet temperature. In general, to heat the catalyst to the proper inlet temperature for the partial conversion zone, the amount of contaminant burned within the partial regeneration zone may range from about 10 to 50 per cent of that deposited on the catalyst in the conversion zone depending upon other operating conditions. In any event, the catalyst should never be permitted to rise to a temperature which would cause permanent heat damage thereto because such heat damage impairs the catalytic effectiveness of the contact material. The temperature above which catalyst will suffer permanent heat damage varies depending upon the type 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 the regenerator the catalyst should similarly be limited below a heat damaging temperature and it should be maintained above the minimum temperature required for contaminant combustion at a practical rate. Such minimum temperature may be of the order of 700° F. to 900° F. depending upon the stage of the regeneration and upon the particular contaminant involved.

In a typical operation on a petroleum crude residium containing substantially no material boiling below about 900° F. the high boiling liquid residuum may be introduced into the upper section of the partial convertor at about 825° F. to contact catalyst introduced at about 1100° F., and be withdrawn from the partial conversion zone and introduced to the conversion zone in the gaseous phase as partially converted hydrocarbons at about 900° F. The catalyst withdrawn from the partial conversion zone is also at about 900° F. The catalyst to oil ratio through the partial conversion zone in this operation may be of the order of 3.5 parts by weight catalyst per part of oil and about 57 per cent of this catalyst throughput is recycled to the partial regenerator, the remaining 43% passing to the final regenerator. In this operation the catalyst to oil ratio in the conversion zone is maintained about 1.5 parts of catalyst by weight per part of oil. The catalyst entered the conversion zone at about 900° F.

It will be understood that the examples of operating conditions, application of the method and apparatus construction and arrangement described hereinabove are merely exemplary in character and are to be in no way construed as limiting the scope of this invention except as it may be limited by the following claims.

We claim:

1. The process for conversion of high boiling petroleum fractions to valuable lower boiling products which comprises: introducing high boiling liquid petroleum fractions into a confined, elongated zone into contact with a stream of hot contaminant bearing contact mass material particles introduced to said zone at a temperature sufficiently high to supply the heat required for conversion of said liquid petroleum fraction to 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 hydrocarbons to valuable lower boiling hydrocarbon products, withdrawing gaseous conversion products from said conversion zone and withdrawing spent contaminant bearing contact material therefrom, passing said spent contact material through a confined partial regeneration zone, passing a combustion supporting gas through said partial regeneration zone in contact with said contact material to effect only the partial burning off of contaminant deposit therefrom and to cause said contact material to be heated to a suitable temperature which is below the heat damaging temperature for said contact material, withdrawing hot partially regenerated contact material from said partial regeneration zone and passing it through said first named confined zone to contact said high boiling liquid hydrocarbons as aforesaid, withdrawing spent contaminant bearing contact material from said first named zone and passing it through an elongated, confined regeneration zone, passing a combustion supporting gas through said regeneration zone to burn off substantially all of said contaminant from said contact material while controlling the temperature of said contact material below a

heat damaging level, withdrawing regenerated contact material from said regeneration zone and passing it to said conversion zone as said stream of regenerated contact material introduced thereinto.

2. In a continuous cyclic process wherein particle form contact material flows cyclically through a conversion zone wherein it is contacted with gaseous hydrocarbons to effect the conversion thereof to valuable lower boiling products and through a regeneration zone wherein a carbonaceous contaminant deposited on said contact material due to hydrocarbon conversion is burned by the action of a combustion supporting gas, the method of preparing a high boiling liquid hydrocarbon charge for introduction to said conversion zone which comprises: passing said high boiling liquid hydrocarbon charge into a separate confined zone into contact with particle form hot contaminant bearing contact material introduced into said zone at a temperature sufficiently high to effect conversion of said liquid hydrocarbon charge to lower boiling gaseous hydrocarbons, passing said lower boiling gaseous hydrocarbons to said conversion zone as the gaseous charge thereto, passing at least a portion of the contaminant bearing contact material from said conversion zone to a heating zone, effecting heating of said contact material in said heating zone to a temperature suitable for its introduction to said separate confined zone while retaining a substantial contaminant deposit on said contact material, passing the heated contaminant bearing contact material from said heating zone to said separate confined zone as aforesaid and passing spent contact material from said separate confined zone to said regeneration zone.

3. In a continuous cyclic conversion process wherein particle form catalyst flows through a conversion zone wherein it is contacted with gaseous hydrocarbons to effect conversion thereof to lower boiling gasoline containing hydrocarbons and causing deposition of a carbonaceous contaminant on said catalyst and through a regeneration zone wherein said contaminant is burned off of said catalyst at controlled elevated temperature, the method of preparing gaseous hydrocarbon charge for said conversion zone from high boiling liquid hydrocarbon charge which comprises: introducing heated high boiling liquid hydrocarbons into a separate partial conversion zone into contact with only partially regenerated catalyst introduced into said zone at a predetermined temperature which is such as will support conversion of said liquid hydrocarbon charge to partially converted gaseous hydrocarbons without said catalyst falling below a temperature suitable for said partial conversion, passing said gaseous hydrocarbons to said conversion zone as said gaseous hydrocarbon charge thereto, passing spent catalyst from said partial conversion zone to said regeneration zone and subjecting spent catalyst from said conversion zone to a partial regeneration by burning sufficient contaminant therefrom to heat said catalyst to said predetermined inlet temperature to said partial conversion zone and passing the partially regenerated catalyst to said partial conversion zone as aforesaid.

4. 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 spent contact material bearing a carbonaceous contaminant from said conversion zone and subjecting said spent contact material to the action of a combustion supporting gas at elevated temperature to burn a portion of said contaminant sufficient to heat said contact material to an elevated temperature which is below that which would cause permanent heat damage to said contact material, passing said heated contact material from which only a portion of said contaminant has been removed, 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.

5. 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 partially regenerated 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 spent contaminant bearing contact material therefrom, passing said spent contact material through a confined partial regeneration zone, passing a combustion supporting gas through said partial regeneration zone in contact with said contact material to effect only the partial burning off of contaminant deposit therefrom and to cause said contact material to be heated to a suitable inlet temperature to said partial conversion zone, passing said partially regenerated contact material into said partial conversion zone, withdrawing spent contaminant bearing contact

material from said partial conversion zone, recycling a portion of said spent contact material from said partial conversion zone to said partial regeneration 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 of the contaminant 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.

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 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 spent contaminant bearing catalyst from said conversion zone and passing it as a substantially compact column through a partial regeneration zone while contacting it therein with a combustion supporting gas to burn off a portion of said contaminant sufficient to heat said catalyst to a suitable inlet temperature to said partial conversion zone, which temperature is below the level which would cause permanent heat damage to said catalyst, withdrawing said catalyst from said partial regeneration zone and introducing it into said partial conversion zone as aforesaid, 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 partial regeneration zone.

7. 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 about 1.0 to 5.0 to 1 and the weight ratio of catalyst to hydrocarbon throughput in said partial conversion zone is controlled within the range about 2.5 to 7.0 to 1.

8. A method for catalytic conversion of a hydrocarbon charge containing material boiling both below and above the desired conversion temperature which method comprises: passing said hydrocarbon charge through a heating zone to heat said charge to a temperature within the range of about 600° F. to 900° F., passing said heated hydrocarbons into a separation zone to separate vaporized gaseous hydrocarbons from liquid hydrocarbons, passing said vaporized gaseous hydrocarbons through an elongated confined conversion zone to contact a stream of particle form catalyst introduced into said zone as substantially regenerated catalyst at a temperature sufficient to supply the heat required for gaseous hydrocarbon conversion to lower boiling gaseous hydrocarbon products and passing the liquid hydrocarbons from said separation zone into a partial conversion zone into contact with a stream of contaminant bearing catalyst introduced into said zone at a temperature sufficient to supply the heat required for conversion of said liquid hydrocarbons to lower boiling, partially converted gaseous hydrocarbons, passing said partially converted gaseous hydrocarbons to said conversion zone to effect conversion thereof to lower boiling finally converted gaseous hydrocarbon products, withdrawing the total gaseous hydrocarbon products from said conversion zone, withdrawing contaminant bearing catalyst from said conversion zone, passing said contaminant bearing catalyst through a partial regeneration zone, withdrawing contaminant bearing catalyst from said partial conversion zone, passing a portion of said catalyst from said partial conversion zone through said partial regeneration zone along with said catalyst from said conversion zone, passing an oxygen containing gas through said partial regeneration zone in contact with said contaminant bearing catalyst to burn off from said catalyst only a portion of said contaminant which is at least sufficient to heat said catalyst to a suitable inlet temperature to said partial conversion zone, passing said catalyst from said partial regeneration zone into said partial conversion zone as aforesaid, passing the remaining portion of contaminant bearing catalyst withdrawn from said partial conversion zone through a total regeneration zone while contacting it with oxygen containing gas therein to burn off from said catalyst substantially all of said contaminant deposited thereon, passing a heat exchange fluid in indirect heat transfer relationship with said catalyst in said regeneration zone to remove at least sufficient heat from said catalyst to control its temperature below a temperature which would cause permanent heat damage thereto, withdrawing substantially regenerated catalyst from said regeneration zone and conducting said substantially regenerated catalyst to a supply zone for introduction into said conversion zone as aforesaid.

9. A method for catalytic conversion of a hydrocarbon charge containing material boiling both below and above the desired conversion temperature which method comprises: passing said hydrocarbon charge through a heating zone to heat said charge to a temperature within the range of about 600° F. to 900° F., passing said heated hydrocarbons into a separation zone to separate vaporized gaseous hydrocarbons from liquid hydrocarbons, passing said gaseous hydrocarbons through an elongated confined con-

version zone to contact a substantially compact column of downwardly moving catalyst particles introduced into said zone as substantially regenerated catalyst at a temperature sufficient to supply the heat required for gaseous hydrocarbon conversion to lower boiling gaseous hydrocarbon products and passing the liquid hydrocarbons from said separation zone into a partial conversion zone into contact with a substantially compact column of catalyst bearing a carbonaceous contaminant and introduced into said zone at a temperature sufficient to supply the heat required for conversion of said liquid hydrocarbons to lower boiling, partially converted gaseous hydrocarbons, passing said gaseous hydrocarbons from said partial conversion zone into said conversion zone to effect conversion thereof to lower boiling, gasoline containing gaseous hydrocarbon products, withdrawing gaseous hydrocarbon products from said conversion zone, withdrawing contaminant bearing catalyst from said conversion zone, passing said contaminant bearing catalyst through a partial regeneration zone, withdrawing contaminant bearing catalyst from said partial conversion zone, returning a major portion of said catalyst from said partial conversion zone to said partial regeneration zone, passing an oxygen containing gas through said partial regeneration zone in contact with said contaminant bearing catalyst to burn off from said catalyst at least sufficient contaminant to heat it to a suitable inlet temperature to said partial conversion zone, withdrawing partially regenerated catalyst from said partial regeneration zone, passing said catalyst from said partial regeneration zone into said partial conversion zone, passing the remaining portion of contaminant bearing catalyst withdrawn from said partial conversion zone through a total regeneration zone while maintaining it within a controlled range of temperatures suitable for combustion of said contaminant but below temperatures which would cause heat damage to said catalyst, passing an oxygen containing gas into contact with said catalyst in said regeneration zone to burn off from said catalyst substantially all of said contaminant deposited thereon, withdrawing substantially regenerated catalyst from said regeneration zone and conducting said substantially regenerated catalyst to a supply zone for introduction into said conversion zone as aforesaid.

10. A method for catalytic conversion of a hydrocarbon charge containing material boiling both below and above the desired conversion temperature which method comprises: passing said hydrocarbon charge through a heating zone to heat said charge to a temperature within the range of about 600° F. to 900° F., passing said heated hydrocarbons into a separation zone to separate vaporized gaseous hydrocarbons from liquid hydrocarbons, passing said gaseous hydrocarbons through an elongated confined conversion zone to contact a substantially compact column of downwardly moving catalyst particles introduced into said zone as substantially regenerated catalyst at a temperature sufficient to supply the heat required for gaseous hydrocarbon conversion to lower boiling gaseous hydrocarbon products and passing the liquid hydrocarbons from said separation zone into a partial conversion zone into contact with a substantially compact column of catalyst bearing a carbonaceous contaminant and introduced into said zone at a temperature sufficient to supply the heat required

for conversion of said liquid hydrocarbons to lower boiling, partially converted gaseous hydrocarbons, passing said gaseous hydrocarbons from said partial conversion zone into said conversion zone to effect conversion thereof to lower boiling, gasoline containing gaseous hydrocarbon products, withdrawing gaseous hydrocarbon products from said conversion zone withdrawing contaminant bearing catalyst from said conversion zone, passing said contaminant bearing catalyst through a partial regeneration zone while contacting it therein with oxygen containing gas to burn off from said catalyst a portion only of said contaminant which is at least sufficient to raise the sensible heat content of said catalyst above its sensible heat content at the desired conversion temperatures in said partial conversion zone to supply the heat required for said conversion in said partial conversion zone, withdrawing said catalyst, still bearing a substantial amount of contaminant from said partial regeneration zone and introducing it into said partial conversion zone as aforesaid, withdrawing contaminant bearing catalyst from said partial conversion zone and passing it through a regeneration zone while maintaining it within a controlled range of temperatures suitable for combustion of said contaminant but below a temperature level which would cause permanent heat damage to said catalyst, passing an oxygen containing gas into contact with said catalyst in said regeneration zone to burn off from said catalyst substantially all of said contaminant deposited thereon, withdrawing substantially regenerated catalyst from said regeneration zone and passing it to said conversion zone as said catalyst introduced thereinto.

11. A process for conversion of a high boiling liquid petroleum fraction to valuable lower boiling products which comprises: passing said high boiling liquid petroleum fraction in heated condition through an elongated partial conversion zone concurrently with a stream of contaminant bearing contact material particle moving downwardly through said zone as a substantially compact column to effect the conversion of said liquid petroleum fraction to lower boiling partially converted gaseous hydrocarbons, passing said gaseous hydrocarbons downwardly through an elongated conversion zone concurrently with a stream of downwardly moving contact material particles moving through said conversion zone as a substantially compact column and introduced into said conversion zone in freshly regenerated condition at a temperature sufficient to permit supply by said contact material of the heat required for conversion of said partially converted gaseous hydrocarbons to lower boiling, gasoline containing gaseous hydrocarbon products without the temperature of said contact material falling below a level suitable for hydrocarbon conversion at a practical rate, withdrawing gaseous hydrocarbon products from said conversion zone and separately withdrawing contaminant bearing contact material therefrom, passing said contaminant bearing contact material through a partial regeneration zone while contacting it therein with sufficient combustion supporting gas to burn from said contact material an amount of contaminant falling within the range 10 to 50 per cent of the amount of contaminant deposited on said contact material in said conversion zone and to heat said contact material to a temperature suitable for supporting the hydrocarbon conversion in said partial conversion zone, passing said partially regenerated contact material

from said partial regeneration zone to said partial conversion zone to supply said column of contact material therein, withdrawing contact material from said partial conversion zone bearing additional carbonaceous contaminant and passing said contact material through a regeneration zone under controlled elevated temperatures while contacting said contact material therein with a combustion supporting gas to burn off from said contact material substantially all of the contaminant deposited thereon, adjusting the temperature of said regenerated contact material to a suitable level for introduction into said con-

version zone and passing said freshly regenerated contact material to said conversion zone as aforesaid.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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