

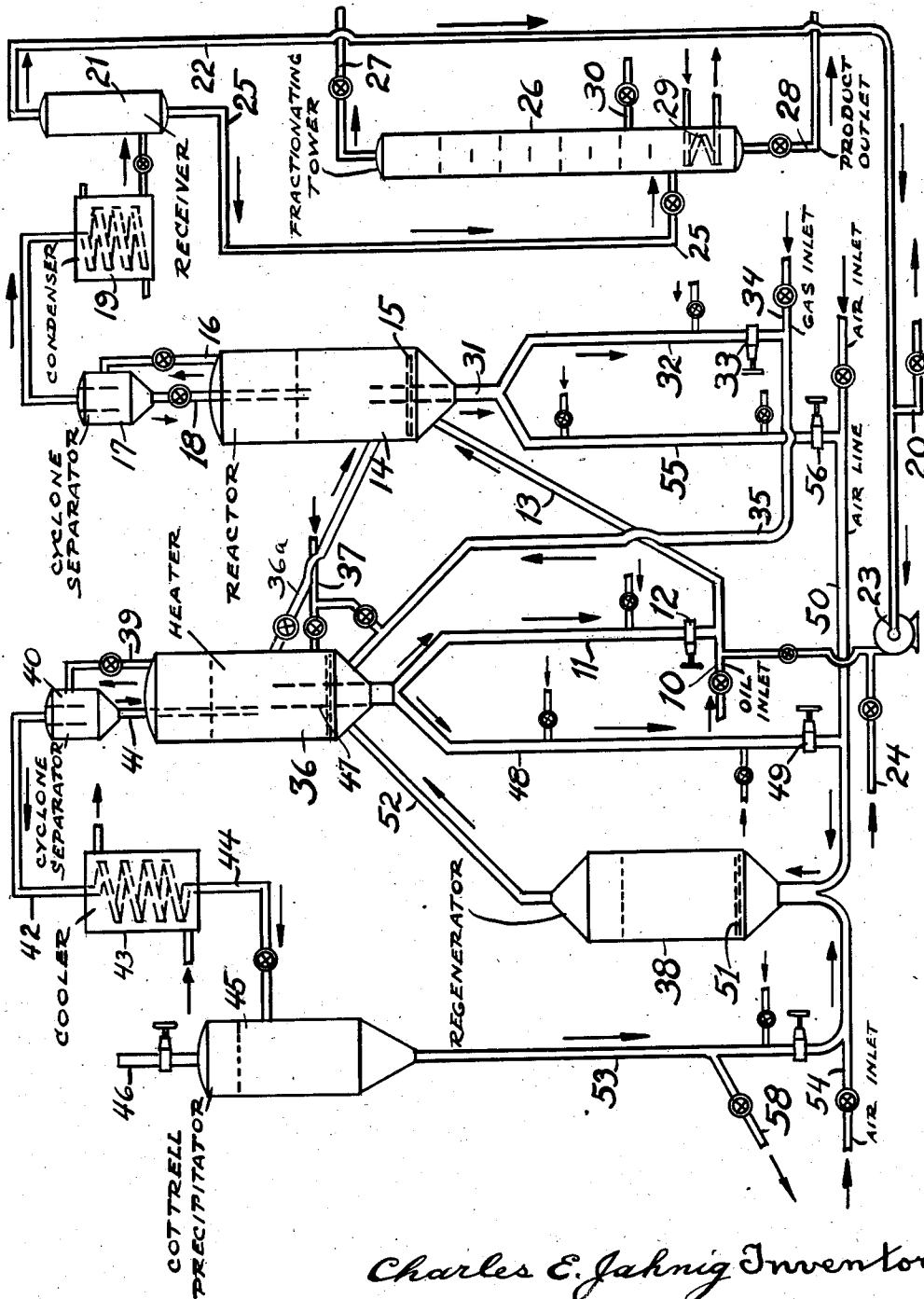
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CONVERSION OF HYDROCARBON OILS

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CONVERSION OF HYDROCARBON OILS

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This invention relates to a process for the conversion of hydrocarbon oils and pertains more particularly to a process for converting hydrocarbon oils in the presence of a finely-divided conversion catalyst.

It has heretofore been proposed to crack hydrocarbon oils to form gasoline and other valuable products in the presence of a finely-divided cracking catalyst. In accordance with this general procedure, the oil to be cracked is passed through a cracking zone containing the catalyst in finely-divided state. The catalyst may be suspended in the oil and carried through the cracking zone along with the oil, or the catalyst may be separately introduced and removed independently of the oil.

During the cracking operation substantial quantities of combustible deposits are normally formed which impair the activity of the catalyst. As a result it has been the practice heretofore to withdraw the finely-divided catalytic material continuously from the cracking zone and to regenerate the material by burning the combustible deposits therefrom. During the burning of the combustible deposits, considerable heat is liberated which may be utilized in carrying out the cracking operation. In most cases, for example, the amount of heat liberated by burning of the combustible deposits formed during the cracking operation is sufficient to supply the heat requirements for the cracking process. In such cases the heat required for the cracking process is introduced into the oil by returning the hot, regenerated catalyst directly to the oil stream while at substantially the regeneration temperature and controlling the relative proportions of catalyst and oil circulating through the cracking and regenerating zone.

In some types of catalytic cracking operations the amount of combustible deposits formed during the cracking operation may be insufficient to supply the required heat for the operation. Furthermore, in other types of oil conversion processes, such as, for example, in the reforming of naphtha, particularly in an atmosphere of hydrogen, and in the dehydrogenation of hydrocarbons, the amount of combustible deposits formed during the reaction is insufficient to supply the heat requirements of the process. Consequently, it is necessary in such operations to add additional heat from some other source, such as by superheating of the oil feed or supplying heat directly to the reaction zone either by external firing or by internal heating elements. One particularly suitable method is to supply fuel to the

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catalytic material in the regeneration zone. In other words, instead of merely burning off the carbonaceous deposits during regeneration, additional fuel may be added during regeneration so as to supply the additional heat required.

However, there are certain disadvantages in the procedure last outlined. In the first place, the efficiency of the regeneration is reduced by the presence of flue gases resulting from the added fuel. In the second place, the addition of fuel to the regeneration zone requires that the catalyst passing through the regeneration zone be continuously subjected to an oxidizing atmosphere which may tend to oxidize the catalyst and thus carry additional oxygen from the regeneration zone into the reaction zone where it would be again reduced at the expense of valuable oil feed. For example, when employing a chromium oxide containing catalyst, the chromium may become oxidized to a higher valence during regeneration and reduced by the feed or product gases to a lower valence during the reaction period.

The primary object of the present invention is to provide a process in which the heat requirements for the operation are supplied by circulating hot, finely-divided catalytic material but which will not be subject to the disadvantages above mentioned.

A more specific object of the invention is to provide a process for the conversion of hydrocarbon oils in which the heat is supplied by circulation of hot, finely-divided catalyst.

Other more specific objects will be apparent from the more detailed description hereinafter in which reference will be made to the accompanying drawing which is a diagrammatic illustration of one form of apparatus suitable for carrying the invention into effect.

Referring to the drawing, the reference character 10 designates a charge line through which the oil to be converted is charged into the system. For illustrative purposes, the process will be described as applied to the reforming of naphthas.

The heavy naphtha to be reformed introduced through line 10 may be at room temperature or it may have been subjected to initial preheating and be either in liquid or vapor phase, or a mixture of both. In any event, the oil at the point of introduction is at a temperature materially below the desired reforming temperature. The oil passing through line 10 intermixes with a hot, finely-divided reforming catalyst discharging from column 11 through control valve 12. The amount of reforming catalyst added to the oil stream is sufficient to heat the oil to the reform-

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ing temperature and to supply the required heat for the reaction. The amount of catalyst introduced into the oil will depend upon the temperature of the catalyst, the temperature of the oil, and the reforming temperature desired.

When operating the reforming treatment at temperatures between 950° F. and 1000° F. with a catalyst within the column 11 at a temperature of 1100° F., the amount of catalyst introduced may range from 3 to 30 or more parts of catalyst per part of naphtha, depending upon the preheat temperature of the oil.

The catalyst employed may be any type of reforming catalyst, such as a mixture of oxides of groups III and VI of the periodic system. A particularly suitable catalyst may comprise, for example, a mixture of chromium oxides and alumina or molybdenum oxides and alumina. The mixture of oil and catalyst passes through transfer line 13 into a reactor 14. The suspension of oil and catalyst is preferably introduced into the bottom section of the reactor 14 below a perforated grid plate 15 and passes upwardly through the grid into the main body of the reactor. The reaction chamber below the grid plate 15 may be of reduced cross-section and the space below the grid may form a distributing zone for distributing the suspension uniformly over the cross-section of the reaction chamber. The oil vapors passing upwardly through the reactor 14 are preferably controlled to permit the finely-divided catalytic material to settle into a relatively dense mass which is maintained in a highly turbulent, fluidized state by the upward passage of the oil vapors there-through. To this end, the velocity of the oil vapors passing upwardly through the main section of the reactor 14 may range from 0.5 to 5.0 feet per second, depending upon the size and density of the catalyst particles.

The gaseous reaction products after passing through the dense, fluidized mass of catalytic material within the reactor 14 are removed overhead through line 16 and may be passed into a cyclone separator 17 or other suitable separating device for removal of entrained catalyst powder therefrom. The catalyst particles separated from the gas stream in the cyclone separator 17 are returned to the reactor 14 through line 18.

The gaseous reaction products after passing through the cyclone separator 17 may pass through a condenser 19 wherein the normally liquid constituents are condensed. The products from the condenser 19 may then pass to a receiver 21 in which the uncondensed gases separate from liquid condensate. Under operating pressures the uncondensed gases will contain a relatively high concentration of hydrogen together with some methane and ethane or other hydrocarbon gases. These gases are preferably recycled to the reaction zone through line 22 and compressor 23. If desired, extraneous hydrogen may be introduced into the system through line 24. Recycle gas is withdrawn, as desired, through line 20.

The reforming operation is preferably carried out under superatmospheric pressure, such as of the order of from 10 to 20 atmospheres, and the amount of hydrogen or recycle gases admixed with the oil may range from 3,000 to 10,000 cubic feet per barrel of oil treated. The temperature may range from 850° F. to 1100° F.

The condensate collected in the receiver 21 may be passed through line 25 to a stabilizer or fractionating tower 26 in which the condensate is subjected to distillation and fractionation to produce a product of the desired volatility. Light volatile

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hydrocarbons not required in the stabilized product may be removed overhead from the stabilizer 26 through line 27 and may be subjected to further processing in suitable equipment (not shown).

The stabilized product may be removed from the bottom of the stabilizer through line 28. Suitable heating elements such as a heating coil 29 may be provided within the stabilizer 26 for supplying the required heat for distillation and fractionation of the product. While separator 17 removes most of the finely-divided contact material, a small amount will be carried over into tower 26 and appear in the bottoms leaving through line 28. This material can be recovered by filtration, settling or other known means and returned to the system. It is often possible to carry out the operation so that the major portion of the products leave from points above the bottom of the tower (e. g. 30) in which case the recovered material is concentrated into a relatively small amount of heavy bottoms and can be returned to the reactor as a slurry.

The reactor 14 is provided with a withdrawal conduit 31 for removal of catalytic material therefrom. The conduit 31 preferably has an extension projecting upwardly through the grid plate 15 into the main body of the reactor. A portion or all of the catalyst withdrawn from the reactor 14 through the withdrawal conduit 31 may be passed through column 32 having a control valve 33 into a stream of carrier gas introduced through line 34 and is carried through line 35 into a heating chamber 36 which may be constructed similar to the reactor 14. The carrier gas into which the catalytic material from the reactor 14 discharges may be an inert gas such as spent combustion gases, steam or the like, or it may be an oxidizing gas such as air, or a fuel gas. The suspension of carrier gas and catalytic material introduced into the heater 36 passes upwardly through the perforated grid into the main body of the heater and the passage of the gases through the heater is controlled to maintain a dense, fluidized mass of catalytic material therein, as previously described in connection with the reactor 14. The catalytic material contained in the heater 36 is heated to a temperature materially above the temperature in reactor 14 by the passage of the hot gases upwardly therethrough. To this end, a fuel gas or liquid may be introduced through line 37. The heating gases may comprise hot carrier gas introduced through line 34 or spent regeneration gases from regenerator 38 herein-after described, or additional fuel and air may be introduced into the heater for heating the catalyst therein. It is preferred, however, to heat the catalyst within the heater 36 in a non-oxidizing atmosphere so as to prevent the oxidation of the catalytic material. The heating gas after passing through the heater 36 is removed overhead through line 39 to a cyclone separator 40 or other suitable separating device for removal of entrained catalytic material therefrom. The catalyst separated from the heating gas in the cyclone separator 40 is returned to the heater 36 through line 41. Line 41 preferably discharges into the heater 36 below the level of catalytic material contained therein.

The heating gas after passing through the cyclone separator 40 may be passed through line 42 to a heat exchanger or cooler 43 which may be in the form of a waste heat boiler or an oil pre-heater in which the temperature of the heating gases is materially reduced. The heating gas

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after passing through the cooler 43 may then pass through line 44 into a Cottrell precipitator 45 for further removal of catalytic material therefrom. The heating gas after passing through the Cottrell precipitator 45 may be rejected from the system through line 46. When using contact materials which deteriorate with use, it is sometimes desirable to reject a portion of the material from the system. For this purpose, material may be removed through line 53.

The catalytic material after being subjected to the required heating in the heater 36 may be removed therefrom through conduit 47. A portion of the heated catalytic material withdrawn from the heater 36 through line 47 may be passed into the column 11 and remixed with the oil as hereinbefore described. The remaining portion of the catalytic material withdrawn from heater 36 through line 47 may be passed through a vertical column 48 and discharged through control valve 49 into a stream of air entering through line 50. The mixture of air and catalyst formed in the line 50 may be then passed into the bottom of regenerator 38 below a perforated grid plate 51. The catalytic material introduced into the regenerator 38 is subjected to oxidizing conditions to remove carbonaceous deposits formed thereon during the reforming operation. The suspension of regeneration gas and catalyst after passing through the regenerator 38 is transferred through line 52 into the bottom portion of the heater 36 below the perforated grid.

The velocity of the air passing upwardly through the regenerator 38 is preferably controlled to maintain a dense, turbulent mass of catalytic material undergoing regeneration therein. As illustrated, the catalytic material is removed from the regenerator 38 along with the spent regeneration gas passing overhead and is again discharged into the heater 36.

The finely-divided material separated in the Cottrell precipitator 45 may be discharged through conduit 53 into a stream of air 54 and passed into the regeneration zone 38. The heat necessary for carrying out the reforming treatment is obtained by circulation of the catalytic material between the reactor 14 and the heater 36, which is separate and independent from the regenerator 38. The amount of catalytic material circulating through the regenerator 38 may therefore be independently controlled to maintain the carbon content of the catalytic material at a predetermined point without the necessity of circulating all of the catalytic material through the regenerating zone wherein it is subjected to an oxidizing atmosphere.

In order to circulate the catalytic material as hereinbefore described, it is necessary to maintain the finely-divided material in a freely flowing, fluidized state. Furthermore, it is necessary to restore pressure on the catalytic material undergoing circulation to recycle or return it to the cracking and regenerating zone, as previously described. To this end, the conduits 11, 31 and 43 may be in the form of a standpipe in which a dense, fluidized mass of catalytic material is maintained so as to develop a fluidstatic pressure at the bottom of said columns sufficient to overcome the pressure drop on the catalytic material undergoing circulation. In order to maintain the material within the columns 11, 31 and 43 in a freely flowing, fluidized state so as to develop fluidstatic pressure at the base thereof, a fluidizing gas may be introduced into the columns at one or more spaced points as indicated.

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In the drawing, the catalyst is removed from the regenerator 38 along with the spent regeneration gas passing through line 52 and is introduced directly into the heater 36. If desired, however, the regenerator 38 may be constructed similar to the heater 36 and the reactor 14, and the regenerated catalytic material may be separately removed from the regenerator 38 through a separate bottom conduit, as illustrated in connection with heater 36 and reactor 14.

In the above description, I have caused the material withdrawn from reactor 14 to pass into the heating zone and a portion of the heated catalyst then passed to the regenerating zone. In some cases, it is desirable to divide the catalyst removed from the reactor and pass a part to the heating zone and the remainder directly to the regenerator. For example, if desired, a portion of the catalyst removed from the reactor 14 may be passed through column 55 and discharged through control valve 56 into the air line 50 from whence it passes directly into the regenerator 38 without first passing through the heating zone. In such case, the column 48 may be omitted or blocked off so that all of the catalytic material from the heating zone 35 is returned to the reactor 14, or, if desired, a portion of the catalyst from the reactor may be combined with a portion of hot catalyst from the heater 36 and the resulting mixture passed to the regenerating zone.

Having described the preferred embodiment of the invention, it will be understood that it embraces such other variations and modifications as come within the spirit and scope thereof.

What is desired to be protected by Letters Patent is:

1. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil in vapor form within said conversion zone with a finely-divided contact material, maintaining said oil within said conversion zone for a period sufficient to obtain a substantial conversion thereof, continuously removing contact material from said conversion zone, passing at least a portion of the contact material so withdrawn through a heating zone, heating said contact material within said heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained within said conversion zone, mixing a portion of the hot contact material from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, passing the mixture so obtained back to said conversion zone, controlling the amount of contact material circulating through said heating and conversion zones to maintain said conversion zone at the desired conversion temperature, regenerating a portion of the contact material withdrawn from said conversion zone and thereafter returning the same to said conversion zone.

2. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil within the conversion zone with a finely-divided contact material, maintaining said oil in contact with said contact material for a period sufficient to obtain a substantial conversion thereof, continuously withdrawing contact material from said conversion zone, passing the contact material so withdrawn through a heating zone, maintaining the contact material within said heating zone in a non-oxidizing atmosphere,

heating said contact material within said heating zone by direct contact with a heating gas to a temperature materially above the temperature within said conversion zone, mixing a portion of the hot contact material from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, continuously passing the mixture so obtained back to said conversion zone, passing another portion of said contact material from said heating zone through a regenerating zone, maintaining an oxidizing atmosphere within said regenerating zone to remove carbonaceous deposits contained thereon, and combining regenerated catalyst with the remainder of said catalyst prior to passing the same to said conversion zone.

3. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil within the conversion zone with a finely-divided contact material, maintaining said oil in contact with said contact material within said conversion zone for a period sufficient to obtain a substantial conversion thereof, continuously removing contact material from said conversion zone, passing a portion of the contact material so withdrawn through a heating zone, heating said contact material within said heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained within said conversion zone, mixing a portion of the hot contact material from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter passing the mixture so obtained to said conversion zone, passing the remainder of said contact material withdrawn from said conversion zone through a regenerating zone, burning combustible deposits contained on said contact material during passage through said regenerating zone, and combining the regenerated contact material with the remainder of the contact material from said heating zone prior to passing the same to the conversion zone.

4. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil within said conversion zone with a finely-divided conversion catalyst, maintaining said oil within said conversion zone for a period sufficient to obtain a substantial conversion thereof, continuously removing finely-divided contact material containing combustible deposits from said conversion zone, passing the contact material so withdrawn through a heating zone, maintaining said finely-divided material during passing through said heating zone in a non-oxidizing atmosphere, heating said contact material within said heating zone to a temperature materially above the temperature maintained in said conversion zone, thereafter passing a portion of the heated conversion catalyst from said heating zone to said conversion zone, controlling the amount of conversion catalyst circulating through said heating and conversion zones to maintain said conversion zone at the desired conversion temperature, passing another portion of the conversion catalyst from said heating zone directly to a regenerating zone, maintaining said conversion catalyst within said regenerating zone in an oxidizing atmosphere to burn combustible deposits therefrom, and thereafter passing said regenerated catalyst to said heating zone.

5. A process for the reforming of hydrocarbon oils which comprises passing a naphtha fraction through a reforming zone, contacting said naphtha within said reforming zone with a finely-divided reforming catalyst, maintaining said naphtha in contact with said catalyst for a period sufficient to obtain substantial reforming thereof, continuously removing finely-divided reforming catalyst from said reforming zone, passing at least a portion of said reforming catalyst through a heating zone, maintaining said reforming catalyst during passage through said heating zone in a non-oxidizing atmosphere, heating said reforming catalyst within said heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained in said reforming zone, mixing at least a portion of the hot reforming catalyst from said heating zone with the naphtha to be converted having a temperature materially below the temperature maintained within said reforming zone, thereafter passing the mixture so obtained to said reforming zone, controlling the amount of reforming catalyst circulating through said heating and reforming zones to maintain said reforming zone at the desired reforming temperature, passing a portion of the reforming catalyst withdrawn from said conversion zone through a regenerating zone, subjecting said catalyst during passage through said regenerating zone to an oxidizing atmosphere to remove carbonaceous deposits formed thereon during the reforming process, and thereafter returning the regenerated catalyst to the reforming zone.

6. A process for the conversion of hydrocarbon oils which comprises passing the oil in vapor form upwardly through a conversion chamber, contacting the vapors during passage through said conversion chamber with a finely-divided contact material, controlling the velocity of the vapors passing upwardly through said conversion chamber to maintain said finely-divided contact material in a relatively dense, fluidized, turbulent state, maintaining said oil vapors in contact with said contact material for a period sufficient to obtain a substantial conversion thereof, thereafter separating conversion products from the finely-divided contact material, continuously removing said contact material from the conversion chamber, passing at least a portion of the conversion catalyst so removed through a heating zone, heating said contact material during passage through said heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained in said conversion chamber, mixing a portion of the hot contact material from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion chamber, thereafter passing the mixture so obtained to said conversion chamber, controlling the amount of contact material circulating through said heating zone and said conversion chamber to maintain said conversion chamber at the desired conversion temperature, regenerating a portion of the contact material removed from said conversion chamber, and thereafter returning the regenerated contact material to the conversion chamber.

7. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil during passage through said conversion zone

with a finely-divided contact material, maintaining the oil in contact with said contact material for a period sufficient to obtain a substantial conversion thereof, continuously removing contact material from said conversion zone, passing at least a portion of the contact material so removed through a heating zone, passing a heating gas upwardly through said heating zone in direct contact with said finely-divided contact material, controlling the velocity of the heating gas passing upwardly through said heating zone to maintain said contact material in a dense, turbulent condition, heating said contact material within said heating zone by contact with said heating gas to a temperature materially above the temperature within said conversion zone, mixing at least a portion of the hot contact material from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter returning the mixture so obtained to said conversion zone, controlling the amount of contact material circulating through said conversion zone and said heating zone to maintain said conversion zone at the desired temperature, regenerating a portion of the contact material removed from said conversion zone in a regenerating zone separate and independent from said heating zone, and thereafter returning the regenerated contact material to the conversion zone.

8. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone, contacting the oil within said conversion zone with a finely-divided conversion catalyst, maintaining the oil in contact with said conversion catalyst for a period sufficient to obtain a substantial conversion thereof, continuously removing conversion catalyst from said conversion zone, passing at least a portion of the contact material so removed through a heating zone, heating said conversion catalyst during passage through said heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained in said conversion zone, mixing a portion of the hot conversion catalyst from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter returning the mixture so obtained to said conversion zone, controlling the amount of conversion catalyst circulating through said heating and conversion zones to maintain said conversion zone at the desired conversion temperature, passing a portion of the conversion catalyst removed from said conversion zone to a regenerating zone, passing an oxidizing gas upwardly through said regenerating zone in direct contact with said finely-divided conversion catalyst, controlling the velocity of the oxidizing gas passing upwardly through said regenerating zone to maintain a relatively dense, fluidized, turbulent mass of conversion catalyst within said regenerating zone, and returning regenerated conversion catalyst to the conversion zone.

9. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted upwardly through a conversion zone containing a body of finely-divided conversion catalyst, controlling the velocity of the oil vapors passing upwardly through said conversion zone to maintain said finely-divided conversion catalyst in a dense, fluidized, turbulent condition, maintaining said oil vapors in contact with said

conversion catalyst within said conversion zone for a period sufficient to obtain a substantial conversion thereof, continuously removing conversion catalyst from said conversion zone, passing at least a portion of the conversion catalyst removed from said conversion zone to a heating zone, passing a non-oxidizing and heating gas upwardly through said heating zone in direct contact with the finely-divided conversion catalyst contained therein, controlling the velocity of the heating gas passing upwardly through the heating zone to maintain said conversion catalyst in a dense, turbulent, fluidized condition therein, heating the conversion catalyst within said heating zone by contact with said heating gas to a temperature materially above the temperature within said conversion zone, mixing at least a portion of the hot conversion catalyst from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter returning the mixture so obtained to said conversion zone, controlling the amount of conversion catalyst circulating through said heating zone and conversion zone to maintain said conversion zone at the desired conversion temperature, regenerating a portion of the conversion catalyst removed from said conversion zone in a regenerating zone separate and independent from said heating zone and returning the regenerated conversion catalyst to the conversion zone.

10. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted in vapor form upwardly through a conversion zone containing a body of finely-divided conversion catalyst, controlling the velocity of the oil vapors passing upwardly through said conversion zone to maintain said conversion catalyst in a relatively dense, turbulent condition, maintaining said oil vapors in contact with said conversion catalyst for a period sufficient to obtain substantial conversion thereof, continuously removing the conversion catalyst from the conversion zone, passing at least a portion of the conversion catalyst removed from said conversion zone through a heating zone, heating said catalyst during passage through said heating zone by direct contact with a heating gas to a temperature materially above the temperature in said conversion zone, mixing a portion of the hot conversion catalyst from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter returning the mixture so obtained to the conversion zone, controlling the amount of conversion catalyst circulating through said heating zone and said conversion zone to maintain said conversion zone at the desired temperature, passing a portion of the catalyst removed from said conversion zone to a regenerating zone separate and independent from said heating zone, passing an oxidizing gas upwardly through said regenerating zone in direct contact with said conversion catalyst contained therein, controlling the velocity of the oxidizing gas passing upwardly through said regenerating zone to maintain a dense, turbulent mass of conversion catalyst within said regenerating zone, and thereafter passing regenerated conversion catalyst from said regenerating zone to the conversion zone.

11. A process for the conversion of hydrocarbon oils which comprises passing the oil to be converted through a conversion zone containing

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a mass of finely-divided conversion catalyst, maintaining the oil in contact with said conversion catalyst within the conversion zone for a period sufficient to obtain a substantial conversion thereof, continuously removing conversion catalyst from said conversion zone, passing at least a portion of the conversion catalyst so removed through a heating zone, passing a heating gas upwardly through said heating zone in direct contact with the conversion catalyst contained therein, controlling the velocity of the heating gas passing upwardly through the heating zone to maintain a dense, turbulent mass of conversion catalyst within said heating zone, heating said conversion catalyst within the heating zone by contact with said heating gas to a temperature materially above the temperature within said conversion zone, mixing at least a portion of the hot conversion catalyst from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said conversion zone, thereafter returning the mixture so obtained to the conversion zone, passing a portion of the conversion catalyst removed from said conversion zone to a regenerating zone, passing an oxidizing gas upwardly through said regenerating zone in direct contact with the conversion catalyst contained therein, regulating the velocity of the regenerating gas passing upwardly through said regenerating zone to maintain a dense, turbulent mass of conversion catalyst therein, and returning regenerated conversion catalyst from said regenerating zone to said conversion zone.

12. A process for cracking hydrocarbon oils which comprises passing the oil to be cracked through a cracking zone in direct contact with finely-divided cracking catalyst contained therein, maintaining the oil in contact with said cracking catalyst within said cracking zone for a period sufficient to obtain a substantial cracking thereof, continuously removing finely-divided cracking catalyst containing carbonaceous deposits from said cracking zone, passing at least a portion of the cracking catalyst removed from said cracking zone to a heating zone, heating the cracking catalyst during passage through said

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heating zone by direct contact with a heating gas to a temperature materially above the temperature maintained in said cracking zone, mixing a portion of the hot cracking catalyst from said heating zone with the oil to be converted having a temperature materially below the temperature maintained within said cracking zone, thereafter returning the mixture so obtained to said cracking zone, controlling the amount of cracking catalyst circulating through said cracking and heating zones to maintain said cracking zone at the desired cracking temperature, passing a portion of the catalyst removed from the cracking zone through a regenerating zone separate and independent from said heating zone, subjecting said catalyst within said regenerating zone to an oxidizing atmosphere to burn carbonaceous deposits contained thereon and thereafter returning the regenerated catalyst to the cracking zone.

13. A process for reforming hydrocarbon oils which comprises passing a naphtha fraction through a reforming zone, contacting said naphtha within said reforming zone with a finely-divided reforming catalyst, maintaining said naphtha in contact with said catalyst within said reforming zone for a period sufficient to obtain a substantial reforming thereof, continuously removing finely-divided reforming catalyst from said reforming zone, passing reforming catalyst so removed through a substantially non-oxidizing heating zone, heating said reforming catalyst during passage through said heating zone exclusively by direct contact with an inert heating gas to a temperature materially above the temperature maintained in the reforming zone, mixing a portion of the hot reforming catalyst from said heating zone with the naphtha to be reformed having a temperature materially below the temperature maintained within said reforming zone, thereafter returning the mixture so obtained to said reforming zone, and controlling the amount of reforming catalyst circulating through said heating and reforming zones to maintain said reforming zone at the desired reforming temperature.

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