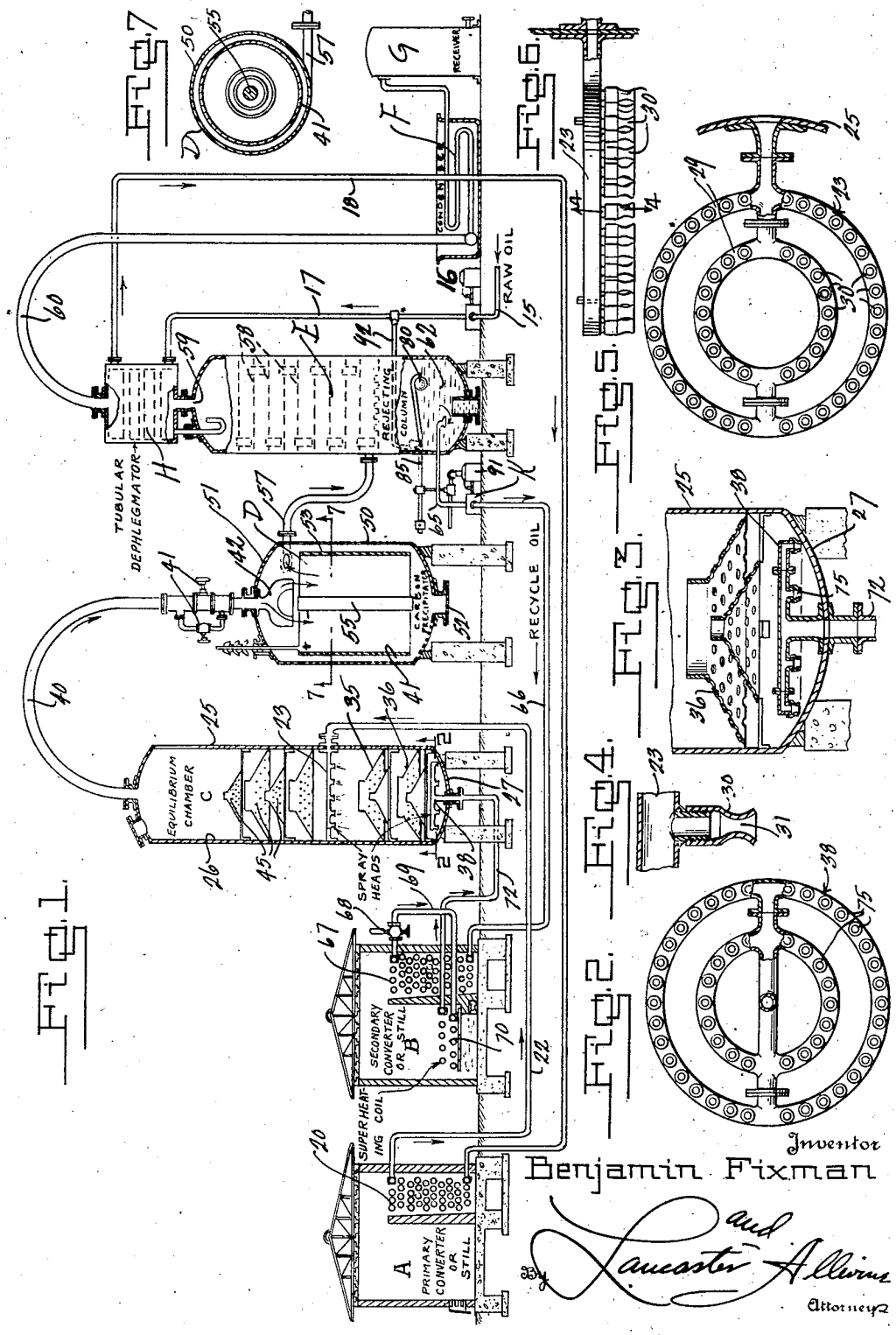
Nov. 18, 1930. B. FIXMAN 1,781,872

PROCESS FOR MAKING MOTOR FUEL

Filed Nov. 18, 1926 2 Sheets-Sheet 1



Inventor
Benjamin Fixman
By Lancaster & Allwine
Attorneys

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Fig. 8.

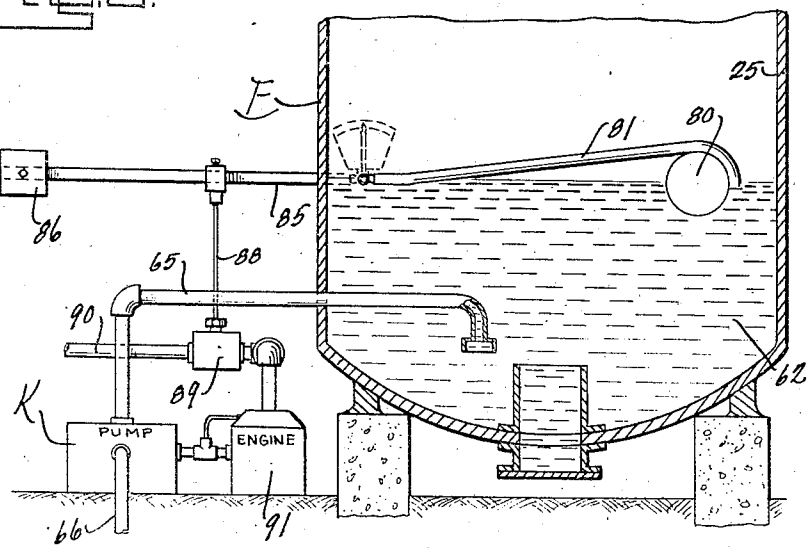


Fig. 9.

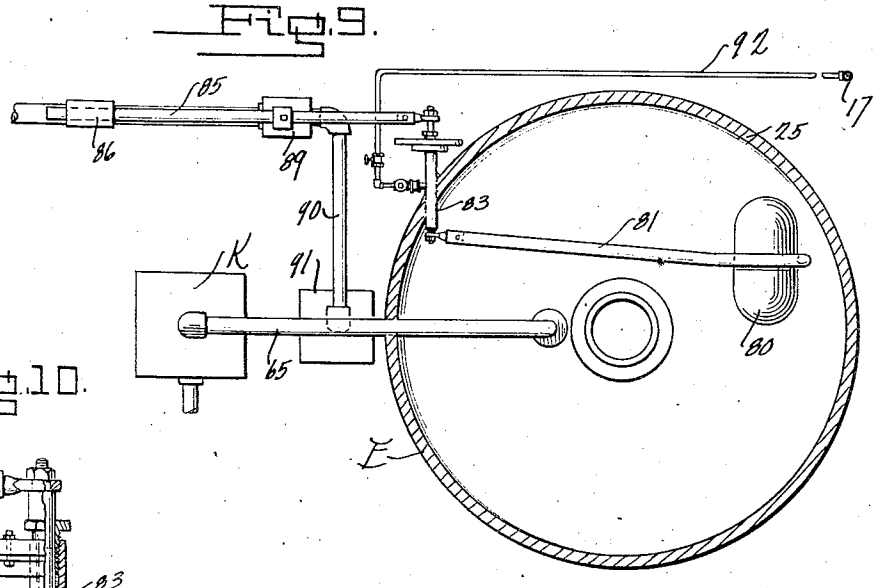
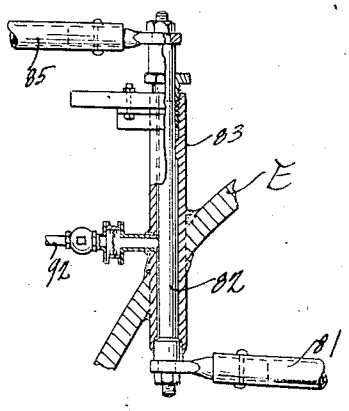


Fig. 10.



Inventor
Benjamin Fixman

By Lancaster and Allwine
Attorneys

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UNITED STATES PATENT OFFICE

BENJAMIN FIXMAN, OF BARTLESVILLE, OKLAHOMA

PROCESS FOR MAKING MOTOR FUEL

Application filed November 18, 1926. Serial No. 149,195.

This invention relates to improvements in processes for converting hydrocarbons of high molecular weight, such as heavy mineral oils, and residual products, into hydrocarbons of lower molecular weight, such as gasoline or motor fuel for automotive internal combustion engines.

The primary object of the invention is the provision of an improved process for carrying out the process, for a continuous and practically quantitative conversion of hydrocarbons of high molecular weight into hydrocarbons of lower molecular weight.

A further object of this invention is the provision of means for initially treating a raw oil in such manner that the optimum conversion temperature is maintained independent of the heat treatment of a recycle stock, which is independently treated under favorable pressure and temperature conditions, so that the raw oil and recycle oil after such treatments may be intermingled in an equilibrium chamber under the most favorable conditions.

A further object of this invention is the provision of process for recovering a maximum yield of gasoline or motor fuel from hydrocarbon oils, which includes the independent heat and pressure treatment of raw and recycle oils in such a relation that the optimum temperature conditions may be obtained, and subsequently mixing the heated products and removing carbon by precipitation and electromagnetic treatment of the same in the vapor phase so as to prevent the contamination of residual oils with carbon and enable the conversion of the ultimate percent of desired fraction within a single system without excessive losses in the formation of carbon and fixed gases.

Other objects and advantages of this invention will be apparent during the course of the following detailed description.

In the accompanying drawings, forming a part of this specification, and wherein similar reference characters designate corresponding parts throughout the several views,

Figure 1 is a diagrammatic representation of the apparatus in which the improved process is carried out.

Figure 2 is a sectional view taken substantially on the line 2—2 of Figure 1.

Figure 3 is a fragmentary vertical sectional view taken through the lower portion of the equilibrium chamber.

Figure 4 is a sectional view taken substantially on the line 4—4 of Figure 6.

Figure 5 is a bottom plan view of an upper spray head used to spray the initially treated raw oil into the equilibrium chamber.

Figure 6 is a side elevation of the spray head illustrated in Figure 5.

Figure 7 is a horizontal sectional view taken substantially on the line 7—7 of Figure 1, through the carbon precipitator.

Figure 8 is a vertical sectional view taken through the lower portion of the rejecting column of the apparatus, showing more particularly float means for regulating the forced pumping of recycle oil from the rejecting column.

Figure 9 is a plan view of details illustrated in Figure 8.

Figure 10 is a sectional view showing the mounting of the float in the rejecting column tank.

In the drawings, wherein for the purpose of illustration is shown only a preferred embodiment of this invention, the letter A may generally designate a primary converter or still in which raw oil is treated; B a secondary converter or still in which the recycle oil is treated; C the equilibrium chamber in which the oil products from the stills A and B are received for novel treatment therein; D a carbon precipitator which receives the resultant fraction from the equilibrium chamber C; E a rejecting column wherein the products are received after treatment in the precipitator D, and from whence the more volatile fractions pass, preferably in vapor phase, through a tubular dephlegmator H and thence into a condenser F, and tank G; the condensate or liquid fraction from the rejecting column E being force pumped by means K to the still B adapted to receive the recycle stock from the rejecting column E.

In the preferred procedure, the raw mineral oil, such as fuel oil, to be converted is caused to flow from any suitable source into

the pipe 15, and is forced by a pump 16 under pressure through a pipe 17, through the dephlegmator H, and out through a conduit 18 and thence into the lower portion of the coil 20 of the primary converter or still A; this coil 20 being of the continuous type, and being externally heated by hot flue gases in any approved manner. In the primary converter the raw mineral oil undergoes conversion at the optimum temperature, which is characteristic of the raw mineral oil at which the molecular structure thereof becomes unstable and cracking occurs without excessive loss due to formation of fixed gases and elementary carbon. It is true that the production of so called fixed gases and elementary carbon bears a direct relation to the temperature at which the raw mineral oil is treated to undergo conversion in the primary converter A, the raw oil alone being treated, without complications resulting from a combined rerun treatment, and therefore the optimum temperature and pressure relation may be carried out. The heated raw mineral oil, in liquid phase, passes from the converter A thru the conduit 22 into a spray head 23 located in the equilibrium chamber C, intermediate the top and bottom thereof, from whence the same is sprayed in the relation to be subsequently described.

The equilibrium receptacle 25 is of the vertical elongated type, providing a compartment 26, wherein the spray head 23 is mounted, above the bottom 27 of the equilibrium receptacle. This spray head 23 is of any approved type, preferably providing a plurality of intercommunicating concentric rings 29, such as shown in Figure 5 of the drawings, the lower surfaces of which are provided with downwardly extending nozzles 30 provided with passageways therethrough which are restricted at 31 adjacent their outlets. The heated raw mineral oil, in liquid phase, is sprayed from the spray head 23, downwardly, in the lower half of the equilibrium compartment 26, and is sprayed into a mass of similar oil undergoing conversion at substantially the same temperature. The equilibrium chamber is maintained under pressure generated by the heat of materials entering the same, of sufficient intensity to keep in a liquid state the substantial portion of the hydrocarbons which have unstable molecular structures at the temperature maintained at the point of entry from the primary converter A. The equilibrium chamber compartment 26 is provided with perforated conical baffles 35 and 36, below the spray head 23, onto which the oil from the spray head is ejected to substantially film out the same and insure a uniform treatment of the same with the upwardly flowing hot vapors from the lower spray head 38, which will be subsequently mentioned. The spray head 38 is located below the baffles 35 and 36, and dispenses hot oil in the vapor phase from the secondary converter B, so as to keep the vapors, liquid, and solid reaction products in a state of intimate contact and homogeneous mixture. The homogeneous mixture of reaction products pass upwardly and out of the top of the equilibrium chamber C, thru a conduit 40, which has pressure regulating valves 41 therein, above the carbon precipitator D, and from whence the said valves vent the products from the conduit 40 into the upper end of the carbon precipitator D, thru a flared distributor 42, which is preferably located concentrically in the upper end of the compartment 41 of the carbon precipitator D.

In the upper end of the equilibrium chamber C, above the spray head 23, a plurality of perforated baffles 45 may be located, to properly intermingle and mix the products in the compartment 26, as they arise thru the conduit 40, from whence the hydrocarbon products for the carbon precipitator D are withdrawn.

A pressure is maintained in the carbon precipitator D, lower than the pressure of reaction in the equilibrium chamber C; the difference in pressures being regulated by the valves 41.

The fact that the hydrocarbons or homogeneous mixture of reaction products, which consists in a large part of superheated vapors carrying a small percentage of liquid by mechanical entrainment, and elementary carbon suspended in the liquid, is expanded into the carbon precipitator D at a lower temperature, insures that the same will assume entirely the vapor phase, excepting of course the elementary carbon and any adsorbed tars.

The carbon precipitator D includes the vertically disposed substantiallv cylindrical shaped receptacle 50, in the top 51 of which the flared distributor 42 is mounted, and which at the bottom thereof may be provided with a manhole 52 or the like. A hollow cylindrical shaped positive electrode 53 is supported concentrically in the carbon precipitator receptacle 50, the same being open at the top and bottom thereof for free passage of the vapor products, and preferably axially in this positive electrode cylinder 53, is supported a negative electrode 55, immediately below the flared distributor 42. The vapors pass thru the electromagnetic field created by the electrodes 53 and 55, first passing downwardly around the negative electrode 55, and tnence reversing their direction at the bottom of the carbon precipitator and passing upwardly and tangentially pass out of the carbon precipitator thru a conduit 57.

In passing thru the electro-magnetic field the elementary carbon is precipitated from the vapors and accumulated within the carbon precipitator, and the vapors pass thru the conduit 57 into the intermediate portion of the rejecting column E, and thence upwardly

thru suitable devised and approved scrubbing trays 58, and the vapor fraction escapes from the rejecting column, thru a passageway 59 in the top thereof, into the tubular dephlegmator from whence the same exits thru a conduit 60 and passes into the condenser F. In the oil cooled dephlegmator H, as well as in the scrubbing trays 58, the unconverted hydrocarbons are precipitated from the vapor stream, in the liquid phase, and this rejected liquid passes counter current to the ascending vapor stream, and settle in a body of liquid 62 in the lower portion of the rejecting column, as is illustrated in Figures 1 and 8 of the drawings.

The incompletely converted hydrocarbons accumulating in the lower portion of the rejecting column E may be conveniently termed the recycle stock, and the same is discharged thru a conduit 65, and force pumped by a pump K into a conduit 66 and thence into the continuous coil 67 of the secondary converter or still B. In the secondary converter B, the recycle stock is externally heated in the coil 67 by hot flue gases. A regulated pressure is maintained in the coil 67 by means of a pressure regulating valve 68 located at the end of the coil 67 opposite the conduit 66, to permit heating of the recycle oil under optimum temperature and pressure conditions, to enable the proper conversion of the same under circumstances which enables the molecules to become unstable and crack. The heated recycle stock after passing the valve 68 is discharged thru a conduit 69 into a superheating coil 70, also located in the secondary converter or still B immediately adjacent the burners of the still B, and in which coil 70 the recycle stock is superheated, and the amount of heat added to the recycle stock in the superheating coil 70 is sufficient to supply the latent heat of vaporization of the raw mineral stock in the equilibrium chamber C and the heat of reaction in the equilibrium chamber. Of course, from the superheating coil 70 the recycle stock passes thru a conduit 72 into the lower end of the equilibrium receptacle compartment 26, by means of the spray head 38. This spray head 38 is formed as more particularly illustrated in Figure 3 of the drawings, having the nozzles 75 thereof directed downwardly towards the bottom 27 of the equilibrium chamber 25, and the vapor phase product as sprayed from the spray head 38 arises, and the reaction products from the recycle stock are caused to mix uniformly with the reaction products from the raw mineral oil which has been sprayed thru the spray head 23, as above mentioned, and this is accomplished by means of the upper parallel flow of all reaction products in their baffled relation.

By means of the intimate prolonged contact between reaction products from the raw mineral oil and recycle stock, as accomplished in the equilibrium chamber C, full advantage is derived from thermo-catalytic synthesis or constructive conversion at elevated temperatures, or association of molecular structures as well as to the cracking reaction or dissociation of molecular structures at elevated temperatures.

As to the means of controlling the operation of the pump K, a float 80 is supported at the free end of the float arm 81; the latter being mounted on a shaft 82 which is rotatably supported in a suitable tube 83 extending transversely through the tank or column E as is illustrated in Figure 10 of the drawings. The shaft 82, at the end extending into the rejecting column E and has the arm 81 rigidly mounting thereon, and at the opposite end exteriorly of the column is rigidly provided with an outwardly extending arm 85 which supports a counter weight 86 at the outer end thereof. Intermediate its ends the arm 85 has a depending connecting rod 88 which operates a slide valve 89 controlling the admission of steam or other operating medium, from the line 90 to the engine 91. Since the engine is electrically operated, the arm 88 may of course operate a switch instead of the valve 89. Of course the engine 91 is for operating the pump K, and upon elevation of the liquid to a proper level the valve will be open for setting the engine 91 in operation and consequently operate the pump K for pumping the recycle stock 62 from the rejecting column E into the secondary converter or still B. Lubrication of the shaft 82 in the sleeve 83 may be effected by forcing oil under pressure thru a conduit 92; this conduit 92 receiving a pressure supply of cold raw oil from the conduit 17, in the relation of parts illustrated in Figure 1 of the drawings.

Referring more in detail to the process and parts of the apparatus thereof, the temperature of the raw oil leaving the primary converter A is of course governed by its composition, and the treatment of the same in the various parts of the apparatus is of course proportionately regulated. By way of example, operating characteristics for a ratio of recycle oil to raw oil, of 5 to 1, in the case of virgin mid-continent raw oils, may be as follows:

Gravity raw oil	A.P.I. temperature raw oil entering equilibrium tank	Temperature recycle oil entering equilibrium tank	Pressure lbs. sq. in. within equilibrium tank	Pressure lbs. sq. in. within carbon precipitator
18-24	750 F.-770 F.	800 F.-820 F.	125-150	30-50
24-30	770 F.-790 F.	820 F.-840 F.	150-175	50-75
30-36	790 F.-810 F.	840 F.-860 F.	175-250	75-150

The heat treatment within the converter B, of the recycle oil is carried out in two steps, namely, a first heating done in the furnace coil 67, wherein the recycle oil is

heated under sufficient pressure to keep it substantially in the liquid phase. As the oil passes valve 68 it expands and assumes substantially the vapor phase, and then passes to the superheated coil 70 which adds the required temperature head for causing the reaction in the equilibrium chamber C.

I have found that the temperature differential between the recycle oil entering the tank C and the raw oil entering tank C, that is necessary to supply the latent heat of the raw oil and the endothermic heat of conversion is about correct to establish the recycle oil at its optimum conversion temperature when the ratio of recycle oil to raw oil is substantially 5 to 1. However, the ratio of recycle oil to raw oil can be raised or lowered with a corresponding reverse movement of said temperature differential until for a given optimum temperature of the raw oil, the optimum temperature will be obtained for the recycle oil entering the tank C. It is therefore evident that the pressure carried in the tank C and in the carbon precipitator are both functions of the ratio of recycle oil to raw oil, and hence I do not wish to be limited to the operating pressures above designated, as these apply merely to raw oil from a particular source. An oil which may be a by-product of other conversion processes or produced from other sources may be of quite different character and require different temperature and ratios of recycle oil to raw oil.

It is very important to have the lower part of the equilibrium tank C maintained as the hottest zone. The unconverted hydrocarbons of highest molecular weight of course remain in the liquid phase in tank C and passes downwardly over the baffles, to approach the highest temperature zones, where they can by reason of the higher temperature more easily undergo conversion, and of course part of the liquid may be entrained by the arising vapors, and in this connection the perforated baffles are important. In order that conversion may be carried out, the time factor of reaction must be considered, and the principle of the arrangement in the equilibrium chamber permits the fullest realization of advantages of the time factor, since the heated raw oil in liquid phase and the heated recycle oil in vapor phase are admitted to the tank C in such manner as to best take care of the time factor necessary to promote conversion under the best circumstances.

The temperature drop due to adiabatic expansion of the vapor from the pipe 40 into the carbon precipitator D, is very small, and it should be noted that this expansion is brought about in order to flash the entrained liquid into vapor at a reduced pressure. As the percentage of entrained liquid is small compared with the weight of vapors, the temperature drop is correspondingly small. While the above table gives the relative difference of pressures between the tanks C and D, these temperatures may vary considerably, and I elect to operate with a minimum pressure drop between the tanks C and D.

The pressure in the rejecting column E may be substantially about 30 pounds, but this may vary, and in this connection the pressures in the tanks D and E are substantially the same.

While the vapors as they pass into the rejecting column are not heated by any apparatus illustrated in the drawings, yet a certain degree of rectification is obtained in the column E by bringing the ascending vapors into the tank E under the lowest drop tray, and if desired the recycle oil which collects in the bottom of the rejecting column may be heated so as to rectify the condensed recycle oil still further.

The condensate in F is stored in a suitable reservoir G.

If desired, a heat exchange device may be placed in the conduit 57 between the precipitator and column E, and through which the recycle oil of conduit 66 may pass to heat said recycle oil in a counter current flow to the hot vapors passing thru the conduit 67.

Various changes in the shape, size, arrangement of parts, as well as in the steps of the process, may be made to the form of invention herein shown and described, without departing from the spirit of the invention or the scope of the claims.

I claim:

1. The process of producing hydrocarbons of substantially the character of motor fuels which consists in heating a raw heavy mineral oil to the conversion temperature under pressure, heating a recycle oil, intimately contacting the heated heavy mineral oil and the reaction products resulting therefrom with the separately heated recycle oil, releasing the resultant hydrocarbon mixture at a reduced pressure which will enable liquid components of the mixture to vaporize, removing carbon from the vapor by electro-magnetic treatment, and separating the hydrocarbons of the desired characteristics from those requiring recycling to produce the recycle oil above mentioned.

2. A process of mineral oil conversion, which consists in heating to conversion temperature a primary body of hydrocarbon maintained in substantially liquid phase, spraying the reaction mass so produced into a pressure equilibrium zone above a heat treated secondary body of hydrocarbon at conversion temperature, withdrawing wet hydrocarbon vapors from the top of the equilibrium zone, expanding the wet hydrocarbon vapors into a zone of lower pressure to dry them, precipitating solid impurities from the vapor so formed by exposing them to a proper electrical field, fractionating the resultant

dry vapors so produced and freed from solid impurities to obtain a desired vapor fraction and a liquid recycle stock, heating the liquid recycle stock while maintained in substantially liquid phase to conversion temperature, vaporizing the recycle stock so heated by expanding it into a heated zone of lower pressure, reheating the recycle stock vapors to restore the conversion temperature existing prior to vaporization, and spraying the said heated recycle stock vapors at conversion temperature into the pressure equilibrium zone first mentioned, said recycle stock vapors at conversion temperature being the heat treated secondary body of hydrocarbon mentioned above.

3. The process of producing hydrocarbons of substantially the character of motor fuels which consists in heating under pressure a primary heavy mineral oil to conversion temperature, separately heating to conversion temperature a recycle oil under higher pressure than the pressure used for the primary oil, reducing the pressure on the recycle oil to substantially the pressure maintained on the primary oil to vaporize the same, reheating the recycle oil vapors so produced to the conversion temperature attained prior to the reduction of pressure, causing the conversion masses of primary and recycle oil to enter a pressure equilibrium zone with the primary oil entering above the point of entry of the conversion mass of recycle oil admitted to the pressure equilibrium zone, regulating the ratio of primary and recycle oils entering the equilibrium zone to prevent a substantial temperature differential between the primary conversion mass before and after entering the equilibrium zone, withdrawing the resultant hydrocarbon mixture from the top of the equilibrium zone, releasing the pressure to enable entrained liquid components to vaporize, removing carbon from the vapor by means of an electrical field, and fractionating the hydrocarbons of the desired characteristics from those requiring recycling to produce the recycle oil above mentioned.

BENJAMIN FIXMAN.