R. B. DAY.

PROCESS FOR TREATMENT OF HYDROCARBON OILS.

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1,357,277.

Patented Nov. 2, 1920.

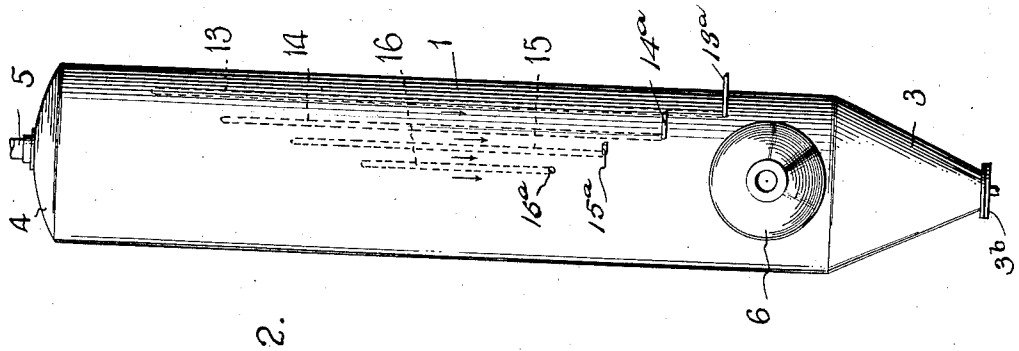


FIG. 2.

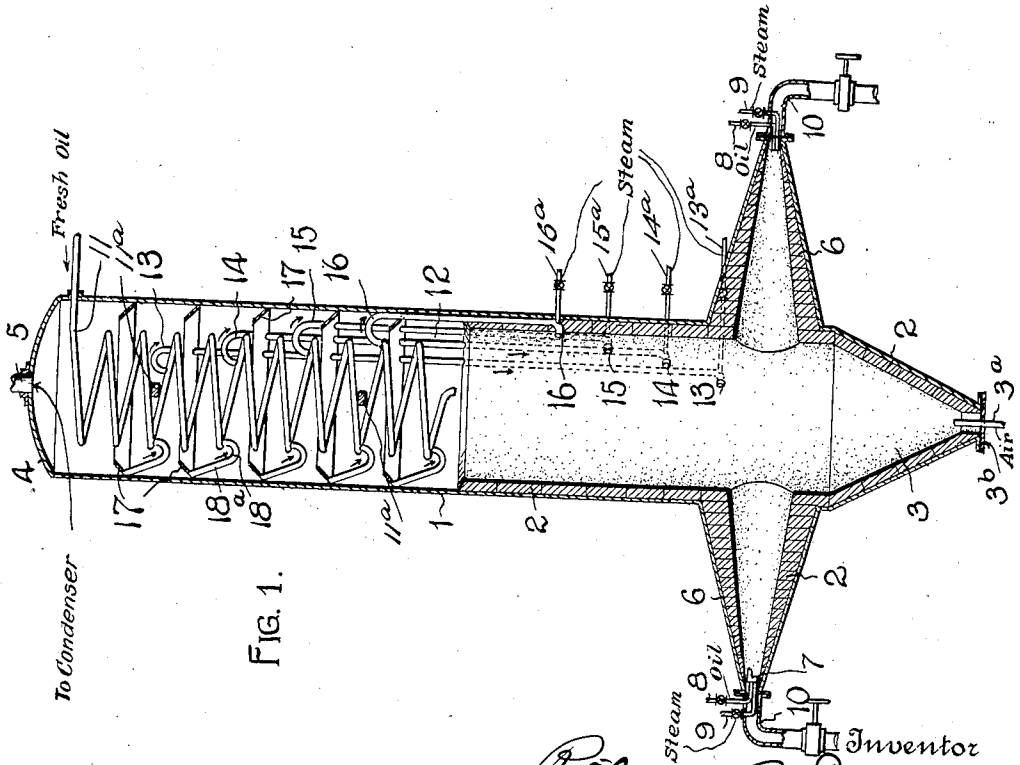


FIG. 1.

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UNITED STATES PATENT OFFICE.

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PROCESS FOR TREATMENT OF HYDROCARBON OILS.

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To all whom it may concern:

Be it known that I, ROLAND B. DAY, a citizen of the United States, residing at Swarthmore, in the county of Delaware and State of Pennsylvania, have invented new and useful Improvements in Processes for Treatment of Hydrocarbon Oils, of which the following is a specification.

This invention relates to processes for producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points. The invention relates particularly to cracking processes in which the hydrocarbon material to be treated is subjected to contact with hot gases of combustion substantially devoid of oxygen whereby the vapors mingle with the hot gases and are cracked thereby.

One feature of the invention is the fractional distillation of the untreated oil and the progressive introduction of the vaporous fractions into contact with a current of the hot gases of combustion in such a manner that the lighter fractions are treated with the hottest gases of combustion to effect cracking and the vapors of the heavier fractions are treated with the progressively cooler gases.

The invention includes the distillation and cracking feature operated at a common pressure and provides certain ranges of temperature for the cracking temperature.

The invention further provides for the generation of the gases of combustion adjacent the base of the cracking apparatus, which is preferably upright, and the distillation of the fresh oil in a supplemental combined condensing and distillation tower located above and as a continuation of the cracking chamber.

The above-mentioned and other features of the invention will be described in detail and claimed in the following specification and claims and described in the drawings, in which—

Figure 1 represents a vertical sectional view through the preferred form of apparatus and adapted to operate the process;

Fig. 2 is an exterior view taken at right angles to Fig. 1 and illustrating the progressive arrangement of the piping for the fractional distillate vapors.

It is generally known that different oils will crack at different temperatures and that in the case of petroleum the lower the boiling point the higher the cracking point. The present invention provides for the application of this fact to the cracking of hydrocarbon oils while in a vaporous condition by contact with hot gases of combustion substantially devoid of oxygen. In carrying the process into effect, the oil to be treated is first separated into a number of different cuts or fractions according to their boiling points and thereafter acted upon by the temperature best suited to each fraction.

The invention provides for the use of an apparatus which is substantially tower-like or cylindrical. In the lower part of this tower, which is of metal, gases of combustion are generated and the quenched gases rise upward through the tower to an outlet at the top. The lower part of the tower, adjacent the source of gases of combustion, is lined with fire brick and constitutes the cracking chamber. The upper portion of the apparatus constitutes a combined fractionating and condensing tower and need not be lined with fire brick as the gases of combustion will be cooled before reaching that part and no cracking will take place. In the combined fractionating and condensing tower is a coil of pipe within which the fresh oil is distilled and fractionated by the heat taken from the current of gases passing. Attached to the inner surface of the combined fractionating and condensing tower are a series of annular troughs adapted to catch condensates of different boiling points and conduct the same into the distilling coil for further subsequent distilling and cracking.

Referring in detail to the drawing, 1 indicates a cylindrical metal casing which stands vertically on any suitable foundation, not shown. The lower half of the interior of the casing 1 is the cracking chamber and because it is subjected to very intense heat, it is lined with fire brick 2 or other material capable of withstanding cracking temperature. The lower end of the cylinder is continued downwardly in a tapered portion 3. The upper end of the cylinder 1 is closed by a top member 4 having formed therein an outlet opening 5 for the passage of vapors which may be driven off to a suitable condenser, not shown. Adjacent the bottom of the cylinder 1 and above the tapered portion 3 are the laterally extending conically shaped hollow burner

extensions 6. These extensions are tightly secured to the cylinder 1 and are a substantially continuous part thereof. Fire brick 2 is also used within the burner extensions 6. At the extreme ends of the extensions 6 and positioned just within the bore of the extension is an oil burner 7 having connected thereto the oil pipe 8 and steam pipe 9. The fire blast from the burners 7 causes considerable pressure and the positive movement of gases upward through the cylinder 1. An elbow pipe member 10 of approximately the same bore as the bore of the abutting end of the extension 6 is fastened to the extension over the end of the bore and extends downwardly. Oxygen or air under pressure may be supplied through the pipe 10 from any suitable source, such as a pump, not shown. The end of the pipe farthest from the cylinder 1 is preferably provided with valve means for closing the same and thus maintaining pressure within the cylinder.

Within the upper portion of the cylinder is a pipe coil 11 illustrated as having nine coils. The upper end of this coil extends to a point beyond the cylinder wall 6 and constitutes the receiving end of the coil for the reception of fresh oil. The lowermost end of the coil is located at a central point within the cylinder and at a point adjacent the top of the fire brick 2, or just beyond the cracking area. At predetermined points, according to fractions to be obtained, lead-off pipes 12 are connected to the top side of the pipe coil 11. The first or topmost lead-off pipe is indicated as 13, the second as 14, the third as 15, and the fourth as 16. The pipes 13, 14, 15 and 16 extend from the coil 11 to the cylinder 1 and downwardly through the brick 2 to predetermined points above the lateral extensions 6, at which points the pipes 13, 14, 15 and 16, project through the casing 1 into the cracking chamber. It will be noted that the topmost pipe 13 is introduced into the cracking chamber at the lowest point and that the other pipes progressively are introduced at points about the same and in inverse relation with respect to their relation to the coil 11. Steam injector pipes 13^a, 14^a, 15^a and 16^a are provided at each point of introduction of pipes 13, 14, 15 and 16 to assist in forcing in the vapors of oil. The rate and force of flow of the steam may be gaged according to the functioning of the other parts of the apparatus and the temperature of the cylinder and the amount of oil being treated.

A plurality of annular collector flanges 17 are mounted around the interior of the upper portion of the cylinder 1 and serve to catch any material condensing on the inner surface of the cylinder 1. Material thus caught is led from the flanges 17 through the pipes 18 into the coil 11. A trap 18^a provides that no vapors or gases from the coil shall pass upwardly through the pipes 18. The collector flanges 17 are located as desirable and are spaced so as to catch condensates of different boiling points which condensates are led back into the coil at points best suited for the further fractionating of the material.

The coil may be supported within the cylinder by any suitable bracing means and as illustrated these braces constitute two rods 11^a extending across the bar of the cylinder and supporting the coil 11 at two different places intermediate of its length.

The lower end of the tapered portion 3 is provided with a pipe 3^a for introducing air to burn out carbon which may fall within the tapered portion or accumulate on the walls of the cracking chamber. A lower cover plate 3^b is also provided for access to the cracking chamber.

In the operation of the process and apparatus, the burners 7 are ignited and oil is pumped into the coil 11. The amount of oil does not fill the bore of the coil pipe but flows only on the lower side thereof in its travel through the coil. The flames from the burners 7 provide a current of intensely hot gases, which rise upward through the cracking chamber and travel around and past the coil 11. The heat vaporizes oil within the coil. Fraction No. 1 as vapor is taken off by pipe 13, fraction No. 2 through pipe 14, fraction No. 3 through pipe 15, and fraction No. 4 through pipe 16. Fraction No. 1 has a lower boiling point because it was heated by the coolest gases, farthest from the burner. Accordingly in order that this distillate can be cracked, it must be subjected to the hottest cracking heat and it is therefore introduced as vapor by pipe 13 at the lowermost point of introduction within the cracking chamber. Fraction No. 2 being taken from the coil 11 at a point farther down, at pipe 14, is necessarily hotter and is led into the cracking chamber above the first fraction. The effect is that the first introduction of oil vapor into the hot gas cooled it to the point where the next fraction would react to the best advantage.

The gases and commingled cracked vapors not condensed on the walls of the cylinder 1 are led out of the opening 5 in the top 4 and passed through any suitable condenser, not shown, and refined as desired.

The invention includes the operation at temperature ranging from 600° to 3000° F. and at pressure ranging up to 600 lbs. per square inch. The temperature of 700° F. is mentioned in the claims to indicate a temperature sufficiently high so that all doubt will be removed that a cracking temperature is used. The apparatus must op-

erate under pressure and the pressure is equalized through the various pipes and other parts of the apparatus.

Any number of fractions could be similarly treated, and the invention is applicable to any type of vapor phase process. Changes in size, shape, and material may be made without departing from the scope of the invention.

What I claim is:—

1. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil.

2. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

3. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

4. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

5. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil, said fractional distillation and said cracking being conducted at the same pressure.

6. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

7. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

8. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced in-

to said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

9. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

10. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

11. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

12. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lighest fraction being conducted at a temperature of at least 700° F.

13. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated and in a vaporous state to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil.

14. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated and in a vaporous state progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

15. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point

adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

16. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydro-carbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases.

17. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated and in a vaporous state to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil, said fractional distillation and said cracking being conducted at the same pressure.

18. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, subjecting the fractions so separated and in a vaporous state to contact with gases of combustion substantially devoid of oxygen, whereby the fractions are cracked, and utilizing the heat of the mixture of cracked material and gases of combustion to fractionally distil additional hydrocarbon oil, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

19. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated and in a vaporous state progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

20. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, and subjecting the fractions so separated and in a vaporous state progressively within a chamber to contact with a current of gases of combustion substantially devoid of oxygen whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

21. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

22. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from

the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

23. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure.

24. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, generating a current of gases of combustion substantially devoid of oxygen within a closed chamber, subjecting the fractions so separated and in a vaporous state progressively within said chamber to contact with said current of gases whereby the fractions are cracked, the lighter fractions being introduced into contact with said gases of combustion at a point adjacent the source thereof and the progressively heavier fractions being introduced into said current of gases of combustion at points progressively removed from the source of said gases, said fractional distillation and said cracking being conducted at the same pressure and the cracking of said lightest fraction being conducted at a temperature of at least 700° F.

25. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists of fractionally distilling the hydrocarbon oil to be treated, providing a heating medium, subjecting the fractions so separated progressively within said chamber to the heat of said heating medium whereby said fractions are cracked, the lighter fractions being subjected to the heat of heating mediums at a point adjacent the source thereof and the progressively heavier fractions being subjected to the heat of said heating medium at points progressively removed from the source of said heating medium.

In testimony whereof I have hereunto set my hand.

ROLAND B. DAY.