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F. G. NIECE

APPARATUS FOR CRACKING HYDROCARBONS

Original Filed July 7, 1921

Fig. 1

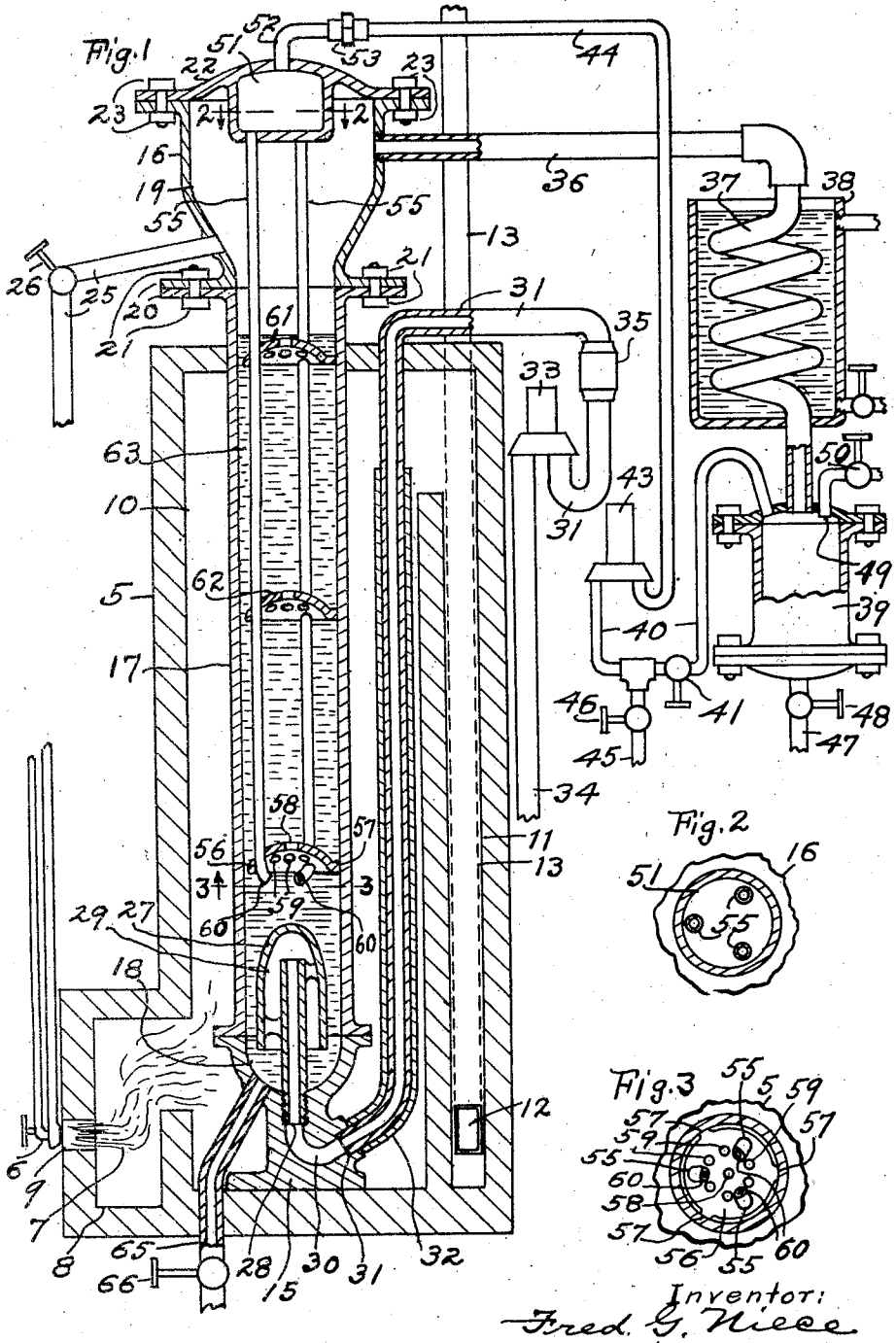

Fig. 2

Fig. 3

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CRACKING HYDROCARBONS.

Original application filed July 7, 1921, Serial No. 482,964. Divided and this application filed July 13, 1921. Serial No. 484,293.

To all whom it may concern:

Be it known that I, FRED G. NIECE, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Apparatus for Cracking Hydrocarbons, of which the following is a specification.

This invention relates to improvements in apparatus for cracking hydrocarbons.

The primary object of this invention is to devise highly practical apparatus for subjecting a hydrocarbon oil heavier than gasoline to such improved and novel treatment as to produce gasoline of better quality and in larger quantity per measure of heavier oil.

Another object is to render said apparatus well adapted for obtaining a remarkably high percentage of saturated hydrocarbons, after having properly started the operation of the apparatus, without resorting to a hydrogen-supply source external to the liquid hydrocarbon to be cracked during said operation.

Another object is not only to produce apparatus of the character indicated for subjecting liquid hydrocarbon to the heat of and within a molten body composed of low-melting metal or material such, for instance, as lead heated to and not vaporizable at the required hydrocarbon-cracking temperature, in a closed chamber having a vapor-outlet, but to have said apparatus comprise means whereby, during the subjection of gases and vapors issuing from heated liquid hydrocarbon to be cracked to the heat of and within said molten body, hydrocarbon vapors and gases which have passed uncondensed through a condenser of the apparatus, after having been subjected to the required hydrocarbon-cracking temperature, are subjected to the heat of and within said molten body.

Another object is to have said apparatus well adapted for effecting such an extensive dissociation of the atomic constituents of molecules of hydrocarbon gases and vapors from the condenser, in such highly intimate or close association in the molten body with the cracking of the vapors and gases from heated liquid hydrocarbon heavier than gasoline, that a plentiful and economical supply of much needed free hydrogen is insured without necessitating the employment of other hydrogen-supplying means.

Another object is to have said apparatus comprise means whereby hydrocarbon gases and vapors from the condenser, and the liquid hydrocarbon to be cracked, can be forced under a desirable pressure into the molten body, and more especially to provide simple and efficient means for maintaining said vapors and gases from the condenser, gases and vapors issuing from heated liquid hydrocarbon to be cracked, and vapors and gases formed during the subjection of hydrocarbons to the heat of and within said molten body, in highly intimate or close association during said subjection of said hydrocarbons to the heat of and within the molten body.

With these objects in view, and to attain any other object hereinafter appearing, this invention consists in certain features of construction, and combinations and relative arrangements of parts, hereinafter described in this specification, pointed out in the claims, and illustrated in the accompanying drawings.

In said drawings, Figure 1 is a side elevation, largely in section and partly diagrammatic, of my improved apparatus. Fig. 2 is a horizontal section taken along the line 2—2 in Fig. 1, looking downwardly. Fig. 3 is a horizontal section taken along the line 3—3 in Fig. 1, looking upwardly.

Referring to said drawings, 5 indicates the casing of a heating furnace shown as comprising an oil-burner 6 arranged as required to have the flame or fire 7 issuing therefrom, during the operation of the furnace, enter the combustion and heating chamber 8 through an aperture 9 in the furnace-front. The forward portion of said chamber extends rearwardly from and above the aperture 9, and the rear portion of said chamber extends farther upwardly, as at 10, and discharges at its upper end into a flue 11 communicating at its lower end, as at 12, with a stack 13.

Surrounded by the portion 10 of said chamber is a hydrocarbon-cracking receptacle shown consisting of a base 15, a top section 16 and an intermediate section 17. The base 15 is secured in place in any approved manner, and the top section 16 is

arranged above and externally of the furnace-casing 5. The intermediate section 17 is formed by a vertical tube which is circular in cross-section and extends between the base 15 and the top section 16. Said tube may have any suitable dimensions, such for instance, as a diameter of from ten to twelve inches and a height of from eight to twelve feet. Said tube forms the surrounding wall of the main portion of the hydrocarbon-cracking chamber, and the base 15 has a cavity 18 which forms the lower end of said chamber. The tube 17 communicates at its upper end with the chamber 19 formed interiorly of the top section 16 and forming the upper end portion of the hydrocarbon-cracking chamber. Preferably adjacent ends of the base 15 and tube 17 are welded together, and adjacent ends of the top section 16 and tube 17 have external flanges 20 removably secured together, as at 21, by bolts and nuts. The chamber 19 of the top section is closed at its upper end by a head 22 removably secured to the body of said section by bolts and nuts, as at 23. Preferably the chamber 19 measures in diameter at its lower end substantially the same as the internal diameter of the tube 17, and is diametrically larger above its lower end portion. An outwardly and downwardly extending pipe 25, having a normally closed valve 26, communicates with the chamber 19 at the lower end portion of said chamber.

Within and centrally of the lower end portion of the hereinbefore mentioned hydrocarbon-cracking chamber is a bell-shaped baffle-member 27 of steel. Said baffle-member is rigid with an upright tubular member 28 which has its upper portion arranged internally and centrally of said baffle-member and is threaded at its lower end into the base 15. The tubular member 28 discharges into the upper portion of the chamber 29 formed interiorly of said baffle-member, and communicates with a bore 30 formed in the base 15.

A pipe 31 for conducting fuel oil, or other liquid hydrocarbon to be cracked, extends from above and into the portion 10 of the heating chamber to the base 15 to which said pipe is secured. Said pipe 31 discharges through the bore 30 into the tubular member 28. The pipe 31 is shown covered, from the base 15 to a point near the upper end of the portion 10 of the heating chamber, with heat-resisting material such, for instance, as asbestos 32, and said pipe therefore has uncovered the upper end of its portion which extends through said chamber, so that the liquid hydrocarbon is preparatorily heated but not overheated while being fed by said pipe. A diagrammatically illustrated oil-pump 33, arranged externally of the furnace, is interposed between the pipe 31 and a pipe 34 for supplying liquid hydrocarbon to be cracked. Said pump is employed in forcing liquid hydrocarbon from the oil supply pipe 34 into the pipe 31 which has a diagrammatically illustrated check-valve 35 for preventing reflux of oil in said pipe.

A vapor-conducting pipe 36, forming the vapor-outlet of the hereinbefore mentioned hydrocarbon-cracking receptacle, communicates with the diametrically larger portion of the chamber 19 in the section 16 of said receptacle and discharges into the vapor-receiving upper end of the upright worm 37 of a condenser. Said condenser comprises a tank 38 containing said worm and kept supplied with cold water. The lower end of said worm forms the outlet of the condenser for the liquid or condensate resulting from condensation of vapor in said worm and discharges into the upper portion of a container or receiver 39 for receiving not only said condensate from the condenser but gases and vapors which have not been condensed in their passage through the condenser. A pipe 40, having a normally closed valve 41, is arranged to conduct gases and vapors from the upper end of and therefore forms a vapor-outlet for the receiver 39, and a diagrammatically illustrated gas-pump 43 is interposed between the pipe 40 and a pipe 44 and employed in forcing gases and vapors into the pipe 44 from the pipe 40. A pipe 45, employed in supplying external hydrocarbon gas when desired and having a normally closed valve 46, communicates with the pipe 40 at a point between the valve 41 and the gas-pump 43. The receiver 39 is provided with a drain-pipe 47 having a normally closed valve 48. The receiver 39 is provided at its upper end with a pipe 49 having a normally closed valve 50 and employed, when desired, in permitting the escape of spent or surplus gases from the receiver. The head 22 of the top section 16 of the hydrocarbon-cracking receptacle is provided centrally with a chamber 51, and the pipe 44 comprises a short pipe-section 52 discharging into said chamber and connected by a union or coupling 53 with the remainder of said pipe. Three substantially corresponding vertical pipes 55 are secured in any approved manner to the bottom of the chamber 51 and spaced circumferentially of the central portion of said bottom, as shown in Fig. 2, and communicate at their upper ends with said chamber and therefore are in communication with the pipe 44. The pipes 55 extend into the lower end portion of the hydrocarbon-cracking receptacle. The lower end portions of the pipes 55 extend through and below a perforated steel baffle-plate 56 arranged substantially horizontally over and near but spaced from the bell-shaped baffle-member 27. The baffle-plate 56 is largely spaced, at and from top to bottom of its circumferential edge, from

the surrounding wall of the hydrocarbon-cracking chamber and (see Fig. 3) has several lugs 57 spaced circumferentially of said plate and arranged to cooperate with said wall in preventing horizontal displacement of said plate. Preferably the baffle-member 27 is smaller diametrically than the baffle-plate 56. The illustrated baffle-plate 56 has a central hole or passage 58 extending vertically through the plate and several holes or passages 59 formed in proximity to and spaced circumferentially of said central passage. The baffle-plate 56 preferably flares downwardly from its central passage 58 and is welded to the pipes 55 which are preferably in close proximity to the outer circumferential edge of said plate. The pipes 55 have their lower and discharging ends arranged under the baffle-plate 56 and over the bell-shaped baffle-member 27 and bent, as at 60, inwardly and toward a point which is below said pipes but central over said baffle-member. Obviously the baffle-plate 56 connects together and braces apart the lower end portions of the pipes 55, and said pipes are similarly connected together and braced apart in the upper end portion of the tube 17 by a perforated baffle-plate 61, and are furthermore connected together and braced apart at a point centrally between the baffle-plates 56 and 61 by an intermediate perforated baffle-plate 62. The baffle-plates 61 and 62 are therefore rigid with the pipes 55, and substantially correspond in dimensions, contour and construction, or characteristics, with the lower baffle-plate 56. By the hereinbefore described construction it will be observed that the pipes 55 are supported from the bottom of the chamber 51 in the head 22, and that the baffle-plates 56, 61 and 62 are connected together by and supported from said pipes and are instrumental in preventing lateral swaying of the pipes.

The joints between component parts of the apparatus are rendered fluid-tight and furthermore formed in such a manner as to withstand heat and strains to which said parts may be subjected, but means for forming such joints are too well known to require description and illustration in this specification. Also, in making said component parts, such metal or material as will withstand the heat and wear and tear to which said parts may be subjected is employed.

The hereinbefore mentioned hydrocarbon-cracking receptacle is supplied with a low-melting metal or material such, for instance, as lead which has a melting point lower than the hydrocarbon-cracking temperature required to be established and maintained in said receptacle during the operation of the apparatus and is readily penetrable, in a molten condition, by hydrocarbon fluids and not vaporizable at said temperature. 63 indicates a molten column or body resulting from the melting of a mass of small pieces of solid lead supplied to the hydrocarbon-cracking receptacle preferably preparatory to the application of the head 22 of said receptacle. In applying said head 22 the pipes 55 and connected baffle-plates 56, 61 and 62 are lowered into the tube 17, and consequently into the molten body 63. Said head 22, upon being secured in place, closes the upper end of the hydrocarbon-cracking chamber, and preferably such a quantity of low-melting metal is introduced into said chamber that, during the subjection of hydrocarbons to the heat of and within the molten body 63, the surface of said molten body is below the upper extremity of the tube 17 and above the upper baffle-plate 61 so that all of the baffle-plates are arranged in and transversely of the molten body. By the hereinbefore described construction and relative arrangement of parts it will be observed that the pipe 40, gas-pump 43, pipe 44, pipe 52, chamber 51 and any pipe 55 constitute means whereby vapors and gases accompanying the condensate passing into the receiver 39 may be supplied into the molten body 63 from the vapor-outlet of said receiver. The hereinbefore mentioned furnace is operated as required to heat the hydrocarbon-cracking receptacle and contents to and maintain them at a hydrocarbon-cracking temperature varying from about four hundred to about seven hundred and fifty degrees centigrade according to the nature of the liquid hydrocarbon to be treated, and the molten body 63 is therefore maintained at said temperature during the operation of the apparatus. Said apparatus is preferably started by opening the valve 46, while the valve 41 remains closed, and operating the oil-pump 33 and gas-pump 43, to force hydrocarbon gas from the pipe 45 to the pipe 44 and thence through the chamber 51 and pipes 55 into the lower portion of the molten body 63, and to force liquid hydrocarbon from the pipe 34 to the pipe 31 and through the chamber 29 in the baffle-member 27 into the lower portion of said molten body, until the development, on the molten body, of a desired gas pressure preferably considerably greater, per square inch, than the pressure exerted at the base of and by the molten body 63 per se. Hydrocarbon gas pumped from the pipe 45 in starting operation of the apparatus is to facilitate establishing the desired gas pressure, but the use of gas from said pipe 45 is not essential, because both valves 41 and 46 may be kept closed while pumping liquid hydrocarbon into the molten body 63 so as to permit establishing a desired gas pressure by the gases resulting from the heating of liquid hydrocarbon in the inner chamber 29 and in the molten body. Were a gas pres-

sure of one hundred and fifty pounds per square inch on the molten body 63 to be established, then as soon as such pressure has developed in the system comprising said apparatus the valve 46 is closed, if not already closed, and the valve 41 opened and left open for establishing a continuous circulation of hydrocarbon fluids in the system. With a gas pressure of one hundred and fifty pounds per square inch on the molten body 63, and with the exertion by said molten body per se at its base of a pressure of forty pounds per square inch, the oil-pump 33 is operated as required to effect the delivery of liquid hydrocarbon preferably under a pressure of about one hundred and ninety pounds per square inch, and the gas-pump 43 is operated as required to force hydrocarbon gases and uncondensed vapors from the condenser into the molten body, and therefore is insured an adequate continuous delivery into the molten body, of gases and uncondensed vapors from the condenser and of liquid hydrocarbon from the pipe 31. That is, during the operation of the system liquid hydrocarbon is continuously forced from the pipe 34 to the inner chamber 29 and thence downwardly through said inner chamber into the lower portion of the molten body, and while liquid hydrocarbon is being forced from said inner chamber into said portion of the molten body gases and vapors from the condenser are continuously forced into said molten body, and vapors and gases (including gasoline vapors) continuously ascend to the surface of said molten body and thence to the pipe 36 and are conducted by said pipe into the worm 37 of the condenser. Distillate or liquid resulting from condensation of vapors in the condenser and entering the receiver 39 is periodically drained through the pipe 47. Gases and uncondensed vapors discharged into said receiver from the condenser are, by and during the operation of the gas-pump 43, supplied to the pipe 44 and thence forced into and through the chamber 51 and connected pipes 55 into the lower portion of the molten body 63. It will be observed that the uncondensed gases received by the chamber 51 in the head 22 serve to positively prevent overheating of said head.

The liquid hydrocarbon to be cracked, being heated in the pipe 31 where the latter extends through the portion 10 of the furnace, is obviously discharged, in a heated condition, into the inner chamber 29, and, as said inner chamber is covered and surrounded by the molten body 63, the already heated liquid hydrocarbon is still further preparatorily heated internally of said inner chamber by heat transmitted through the walls of said inner chamber from said molten body and to such an extent that the hot liquid hydrocarbon, when it passes from within said inner chamber into the molten body, has been heated substantially to or somewhat above the melting point of the lead or material composing the molten body, so that said liquid hydrocarbon is in a desirable condition for entering without chilling the molten body. Also, it will be observed that vapors passing to and uncondensed through the condenser from the hydrocarbon-cracking temperature in the molten-body-containing chamber or receptacle, and gases accompanying said vapors, are not only forced into the lower portion of the molten body 63 but heated, in their passage through the chamber 51 and pipes 55, to a temperature substantially as high as the melting point of the material composing the molten body, so that said vapors and gases are discharged in a desirably heated condition into the molten body. The heated liquid hydrocarbon forced into the inner chamber 29 is in the main still liquid while passing from said chamber into the molten body 63 and ascends externally of the baffle-member 27, and said heated liquid hydrocarbon and accompanying gases and vapors, and vapors and gases resulting from the subjection of said liquid hydrocarbon to the heat of and within the molten body, ascend under and toward the baffle-plate 56 and into intimate association with the hot hydrocarbon gases and vapors transmitted from the condenser and discharged under said baffle-plate from the pipes 55. The discharge of the liquid hydrocarbon into the molten body at a point spaced downwardly from the discharge of gases and vapors from the pipes 55 permits a greater production of newly formed vapors and gases issuing from said liquid hydrocarbon before any gases and vapors arising in the molten body from said liquid hydrocarbon have ascended far enough to become intimately associated with vapors and gases discharged into the molten body from said pipes. The inward projection 60 of the discharging ends of said pipes 55 and the downwardly flaring shape of the baffle-plate 56 are helpful in effecting an intimate association of all hydrocarbons between said baffle-plate and the baffle-member 27, and more especially is said baffle-plate 56 effective in retarding the ascent of heated liquid hydrocarbon from between said baffle-plate 56 and the baffle-member 27, and in a detention, under said plate 56, of intimately associated vapors and gases from the condenser and gases and vapors arising or issuing from said liquid hydrocarbon. Substantially all of the hydrocarbons under the baffle-plate 56 are compelled to pass from under said plate through the passages 58 and 59 in said plate into the molten mass between said plate and the intermediate baffle-plate 62. Said intermediate baffle-

plate is helpful in producing and maintaining an intimate association of vapors and gases from the condenser and gases and vapors arising from liquid hydrocarbon in the molten body between said plate and the lower baffle-plate 56 and in retarding the ascent of said liquid hydrocarbon from between said plates. Hydrocarbons between the baffle-plates 56 and 62 ascend to and through the holes or passages in the intermediate baffle-plate 62. The upper baffle-plate 61 operates substantially the same as the intermediate baffle-plate 62 and is helpful in producing and maintaining an intimate association of hydrocarbons ascending toward said upper baffle-plate from the intermediate baffle-plate. Obviously the baffle-plates 56, 61, and 62 constitute means whereby is effected a baffling, at different heights in the molten body and above all discharges of hydrocarbons into the molten body, of ascending hydrocarbons, because each baffle-plate is instrumental in temporarily obstructing movement of ascending hydrocarbons in the molten body. Hence by the baffling means comprising the baffle-plates 56, 61 and 62 is insured a highly intimate and close association of hydrocarbons between adjacent baffle-plates and between the lower baffle-plate and the baffle-member 27 while said hydrocarbons are subjected to the heat of and within the molten body. The hereinbefore described apparatus has been found highly practical for the economical production of gasoline of better quality and in larger quantity per measure of liquid hydrocarbon to be cracked, with no appreciable loss of material, and with little or no appreciable formation or accumulation of carbon in any portion of the apparatus. Furthermore, were an undesirable accumulation of carbon to occur in treating some hydrocarbons after operating the apparatus continuously for many days, said carbon will be found in a finely divided state and mainly, if not entirely, in the top section 16 of the hydrocarbon-cracking receptacle. The pipe 25 can be employed as an outlet for carbon in case of an undesirable accumulation of carbon in said section 16. The base 15 of the hydrocarbon-cracking chamber is shown provided with a drain-pipe 65 through which, upon opening a normally closed valve 66 with which said pipe is provided, the molten metal may be drained from said chamber. Obviously upon stopping the operation of the apparatus and removing the molten metal 63 through the pipe 65, only detachment of the pipe 36 from the section 16, and the required manipulation of the coupling 53 as required to separate the pipe-section 52 from the remainder of the pipe 44, are required to render said section 16 free to be hoisted and removed, for cleaning or other purposes, upon detaching said section 16 from the tube 17. Also, only said manipulation of said coupling and detachment of the head 22 are required to render said head and connected pipes 55 and baffle-plates 56, 61 and 62 free to be hoisted and removed.

Of considerable importance to the most highly successful operation of the hereinbefore described apparatus are the hereinbefore described means for temporarily obstructing movement of ascending hydrocarbons in the molten body 63 and thereby effecting such a thorough and extensive cracking of gases and vapors from the condenser, in such intimate association in the molten body with other hydrocarbon vapors and gases being cracked in the molten body, that an adequate supply of much needed free hydrogen for producing saturated hydrocarbons without resorting to a hydrogen-supply source external to the liquid hydrocarbon to be cracked, and a larger production of high grade gasoline than heretofore per measure of heavier liquid hydrocarbon to be cracked, are insured. Important to the efficiency of said apparatus is its suitability for an expeditious establishment, in the system and without the necessity of introducing an external pressure medium into the system, of a gas pressure considerably greater than the pressure exerted at its base by the molten body 63 per se, and to force the hydrocarbons to be cracked into the molten body under a pressure as great as the sum of the two pressures already mentioned in this sentence. Also meritorious is the hereinbefore described means of transmitting vapors and gases from the condenser to the molten body 63 independently of the heated liquid hydrocarbon to be cracked, and the means whereby said liquid hydrocarbon is forced into an inner chamber 29 formed at the lower portion of and covered by and discharging into the molten body. Essential to said apparatus is its suitability for practising a hydrocarbon-cracking process in which, while the molten body 63 heated to the required hydrocarbon-cracking temperature is being penetrated by vapors and gases issuing from heated liquid hydrocarbon heavier than gasoline, is effected the penetration of said molten body by hydrocarbon gases and vapors which have passed into and uncondensed through a condenser of said apparatus after having been subjected to said temperature.

The condensate accumulating in the condensate-collecting chamber formed by the receiver 39 of the hereinbefore described apparatus is a remarkably clean-appearing and at least translucent and sometimes transparent liquid which, with great facility and at a remarkably low cost, is chemically treatable in any approved manner and sometimes requires only distillation and filtering

to produce a clean and transparent high-grade gasoline.

I would also remark that of vast importance to a highly successful operation of my improved apparatus is the condensate-collecting chamber having a vapor-outlet and arranged to receive the condensate and accompanying vapors and gases from the condenser, that from ten to fifteen per cent, or more, of the vapors and gases passing into said condensate-collecting chamber with the condensate consists of illuminants or unsaturated compounds (C_nH_{2n}), that of vast importance therefore to a highly successful operation of my improved apparatus is any means whereby vapors and gases which have passed from the condenser into the condensate-collecting chamber may be fed or supplied from the vapor-outlet of said chamber into a molten body within and to the heat of which other hydrocarbon is to be subjected, so that during the subjection of the last-mentioned hydrocarbon to the heat of and within said molten body vapors and gases from the vapor-outlet of the condensate-collecting chamber may be subjected to the heat of and within said molten body, and that therefore the vapors and gases fed from the condensate-collecting chamber into the molten body and newly produced hydrocarbon gases and vapors which have issued from liquid hydrocarbon fed into the molten body become intimately associated within the molten body, and enough hydrogen is liberated during the operation of and within my improved hydrocarbon-cracking system without necessitating any resort to a hydrogen-supplying means external to the liquid hydrocarbon to be treated.

It will be observed that the hereinbefore described apparatus is more especially designed both for the subjection of newly produced gases and vapors which have issued from heated liquid hydrocarbon to the heat of and within a molten body and for the subjection, to the heat of and within said molten body, of the hereinbefore mentioned vapors and gases from the aforesaid condensate-collecting chamber, and the operation of said apparatus as hereinbefore described results in a highly economical production of gasoline in larger quantity and of higher saturation than heretofore.

Not unimportant also is the spacing of each baffle-plate of the vertically spaced baffle-plates 56, 61 and 62 in the main from the outer circumference of the molten body to permit surging or movement of molten metal up and down between the surrounding wall of the molten-body-containing chamber and the outer circumferential edges of the baffle-plates during ascent of hydrocarbons between adjacent baffle-plates and through the passages 58 and 59 in the said baffle-plates, and more especially to permit molten metal to descend at the outer circumference of each baffle-plate so that there is no liability of molten metal being driven or carried or caused to pass to the vapor-outlet 36 of said chamber during an unduly vigorous ascent of molten-body-penetrating hydrocarbons.

As hereinbefore indicated, my improved hydrocarbon-cracking apparatus more especially comprises a relatively tall hydrocarbon-cracking receptacle, a relatively high column of the molten lead or contact substance composing the molten body 63 contained in said receptacle, means whereby fresh hydrocarbons may be delivered into the lower portion of and in contact with said molten column, and means whereby non-condensible hydrocarbon gases already subjected to a hydrocarbon-cracking temperature of a former hydrocarbon-cracking treatment may be fed into the lower portion of and into contact with said column, and therefore said non-condensible gases and the aforesaid fresh hydrocarbons are caused to ascend a relatively long distance in contact with and within said column during the travel of said fresh hydrocarbons and said non-condensible gases through said column so as to afford ample opportunity for intimate association of atoms and compounds resulting from the cracking of said fresh hydro-carbons, with atoms and compounds resulting from the cracking of the aforesaid non-condensible gases, and so as to result in an appreciable increase, within said column, in the production of hydrocarbon compounds capable of yielding, by subsequent condensation, an increased measure of motor fuel or low boiling hydrocarbons. I would also remark that by the provision of means for feeding the uncondensed gases into the molten body from the condensate-collecting chamber the yield of gasoline is from three to ten per cent greater than it would be were uncondensed gases only fed into said molten body from a point in advance of said chamber.

The hydrocarbon-treating process disclosed in this specification is claimed in a divisional application, Serial Number 482,964, for United States Letters Patent, the date of filing said application being July 7, 1921.

What I claim is—

1. Apparatus of the character indicated comprising a hydrocarbon-cracking receptacle which has a vapor-outlet and comprises an interiorly chambered head arranged to form a closure for the upper end of said receptacle, a molten column contained in said receptacle and penetrable by hydrocarbons and not vaporizable at the desired hydrocarbon-cracking temperature, a condenser, means for feeding hydrocarbon gases and vapors to said condenser from the aforesaid

vapor-outlet, means whereby gases which have passed uncondensed through the condenser may be supplied to the interior chamber in the aforesaid head, an upright pipe placed in communication with said chamber and extending into the aforesaid molten column and communicating at its lower end with said molten column, and means for delivering fresh hydrocarbons into contact with and interiorly of said column at a point below said lower end of said pipe.

2. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and an interiorly chambered head and contains a molten body penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, a condenser for receiving hydrocarbon gases and vapors from said vapor-outlet, means whereby vapors and gases which have passed uncondensed through the condenser may be supplied to the interior chamber of the aforesaid head, pipes communicating with said chamber and spaced circumferentially of the central portion of and rigid with the bottom of said chamber and extending and discharging into the lower portion of the aforesaid molten body, and means whereby other hydrocarbon to the cracked may be supplied to said lower portion of the molten body.

3. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons under pressure and heated to but not vaporizable at the required hydrocarbon-cracking temperature, means for supplying hydrocarbons to said molten body, and a downwardly flaring baffle-plate arranged in and transversely of the molten body and over the discharge of hydrocarbons into the molten body and having a central hole or passage adapted to permit hydrocarbons to pass upwardly through the plate.

4. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons under pressure and heated to but not vaporizable at the required hydrocarbon-cracking temperature, means for supplying hydrocarbons to said molten body, and a perforated baffle-plate arranged in and transversely of said molten body and over the discharge of hydrocarbons into the molten body, said plate being spaced, at and from top to bottom of its circumferential edge, from the outer circumference of the molten body.

5. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, a condenser, means for feeding hydrocarbon gases and vapors to said condenser from the aforesaid vapor-outlet, means for temporarily obstructing movement of ascending hydrocarbons in the aforesaid molten body at a point spaced upwardly from the bottom of the molten body, means for injecting hydrocarbon oil into said molten body at a point spaced downwardly from said obstructing means, and means for feeding uncondensed gases from the condenser into the molten body between said obstructing means and the discharge from the oil-injecting means.

6. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons under pressure and heated to but not vaporizable at the required hydrocarbon-cracking temperature, a condenser for receiving hydrocarbon gases and vapors which have been subjected to said temperature, means whereby other hydrocarbon to be cracked may be supplied to the lower portion of the aforesaid molten body, a perforated baffle-plate arranged in and transversely of said molten body and above the point at which the last-mentioned hydrocarbon is discharged into said molten body, a pipe rigid with said baffle-plate and discharging into the molten body under said plate and supported from the aforesaid receptacle, and means whereby vapors and gases which have passed uncondensed through the condenser may be supplied through said pipe to the molten body.

7. Apparatus of the character indicated comprising a closed receptacle which is provided at its upper end with a head and has a vapor-outlet and contains a molten body penetrable by hydrocarbons under pressure and heated to but not vaporizable at the required hydrocarbon-cracking temperature, a condenser for receiving hydrocarbon gases and vapors which have been subjected to said temperature, means whereby other hydrocarbon to be cracked may be supplied to the lower portion of the aforesaid molten body, a perforated baffle-plate arranged in and transversely of said molten body and above the point at which the last-mentioned hydrocarbon is discharged into the molten body, a pipe connected to the aforesaid head and extending through and supporting said baffle-plate and discharging at its lower end into said molten body, and means whereby vapors and gases which have passed uncondensed through the condenser may be supplied through said pipe to said molten body.

8. Apparatus of the character indicated comprising a closed receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons under pressure and heated to but not vaporizable at the required hydrocarbon-cracking temperature, a

condenser for receiving hydrocarbon gases and vapors which have been subjected to said temperature, means whereby other hydrocarbon to be cracked may be supplied to the lower portion of the aforesaid molten body, vertically spaced perforated baffle-plates arranged in and transversely of said molten body and above the point at which the last-mentioned hydrocarbon is discharged into the molten body, pipes extending through the baffle-plates at points spaced circumferentially of the central portions of the plates and having their lower ends turned inwardly and discharging into the lower portion of the said molten body, and means whereby vapors and gases which have passed uncondensed through the condenser may be supplied through said pipes to said molten body.

9. Apparatus of the character indicated comprising a hydrocarbon-cracking receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, a condenser, means for feeding hydrocarbon gases and vapors to the condenser from the aforesaid vapor-outlet, an inner chamber formed within and discharging into said molten body, means for feeding hydrocarbon into the molten body through said inner chamber, and means for feeding, into said molten body and externally of said inner chamber, gases and vapors which have passed uncondensed through the condenser.

10. Apparatus of the character indicated comprising a hydrocarbon-cracking receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, a condenser, means for feeding hydrocarbon gases and vapors to the condenser from the aforesaid vapor-outlet, a condensate-collecting chamber arranged to receive condensate and accompanying vapors and gases from the condenser and having a vapor-outlet, an inner chamber formed at the lower portion of and discharging into the aforesaid molten body, means for supplying a hydrocarbon to said inner chamber, and means for feeding, into said molten body and externally of said inner chamber, vapors and gases from the aforesaid vapor-outlet of the condensate-collecting chamber.

11. In apparatus of the character indicated, the combination, with a closed receptacle having a vapor-outlet and containing a molten body which is penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, said receptacle having a closed chamber which is spaced upwardly from said molten body and also having a chamber which is formed at the lower end portion of and discharges into said molten body, of means for supplying gases under pressure into the first-mentioned chamber, means for feeding gases from said first-mentioned chamber into the aforesaid molten body, and means whereby a hydrocarbon may be delivered through the second-mentioned chamber into said molten body.

12. Apparatus of the character indicated comprising a hydrocarbon-cracking receptacle which has a vapor-outlet and contains a molten body penetrable by hydrocarbons and not vaporizable at the required hydrocarbon-cracking temperature, an inner chamber within the lower portion of said molten body and discharging at its lower end into the molten body, means for forcing liquid hydrocarbon into said chamber, an upright hydrocarbon-feeding pipe externally of said inner chamber and internally of the hydrocarbon-cracking receptacle and discharging into the lower portion of and extending above said molten body, and a perforated baffle-plate connected to said pipe at a height above the discharge from said pipe into the molten body and arranged in and transversely of the molten body and spaced in the main from the outer circumference of the molten body.

13. Apparatus of the character indicated comprising a hydrocarbon-cracking receptacle which has a vapor outlet and comprises an interiorly chambered head arranged to form a closure for the upper end of said receptacle, a molten column contained in said receptacle and penetrable by hydrocarbons and not vaporizable at the desired hydrocarbon-cracking temperature, a condenser, means for feeding hydrocarbon gases and vapors to the condenser from the aforesaid vapor-outlet, a condensate-collecting chamber for receiving condensate and accompanying gases from the condenser, means for feeding gases from said condensate-collecting chamber to the interior chamber of the aforesaid head, means for supplying gases from the last-mentioned chamber to the interior of and into contact with the aforesaid molten column, and means for delivering fresh hydrocarbons into contact with and interiorly of the lower portion of said molten column.

In testimony whereof, I sign the foregoing specification, this 11th day of July, 1921.

FRED G. NIECE.