March 16, 1937. H. C. WEBER ET AL 2,074,196

HYDROCARBON OIL CONVERSION

Filed Jan. 6, 1932 2 Sheets-Sheet 1

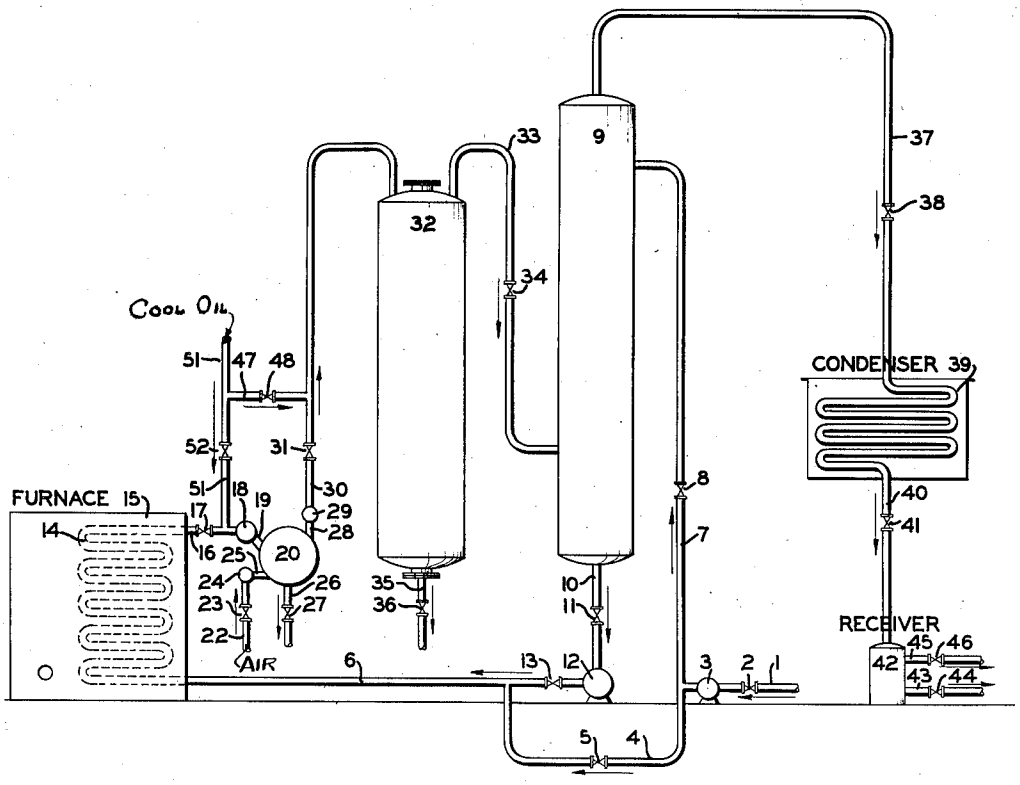


FIG. 1

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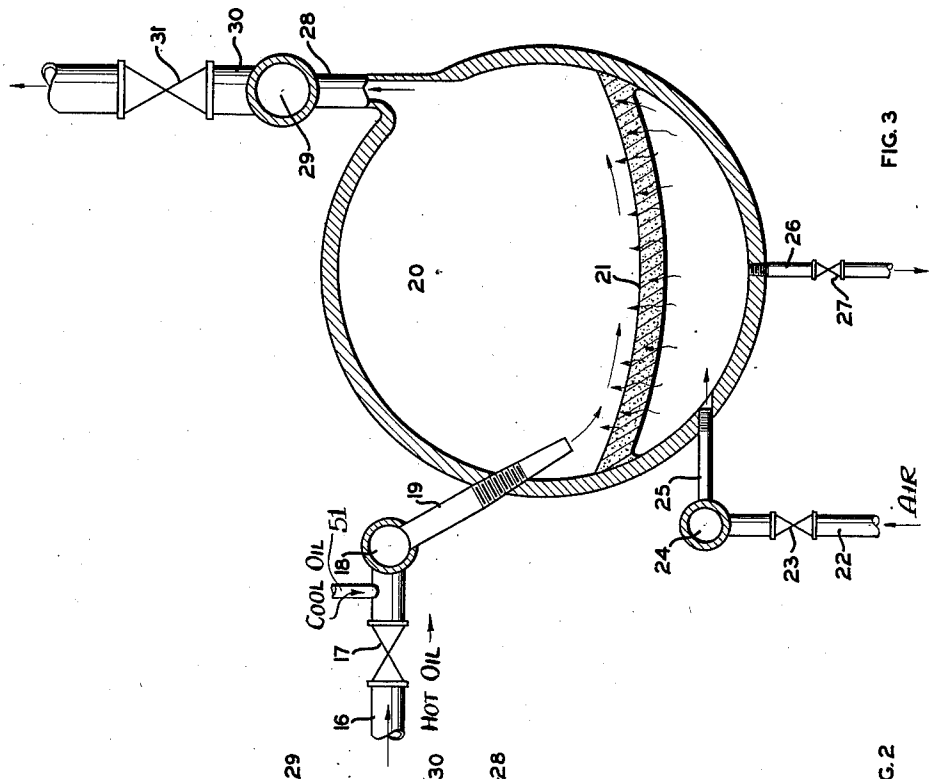


FIG. 3

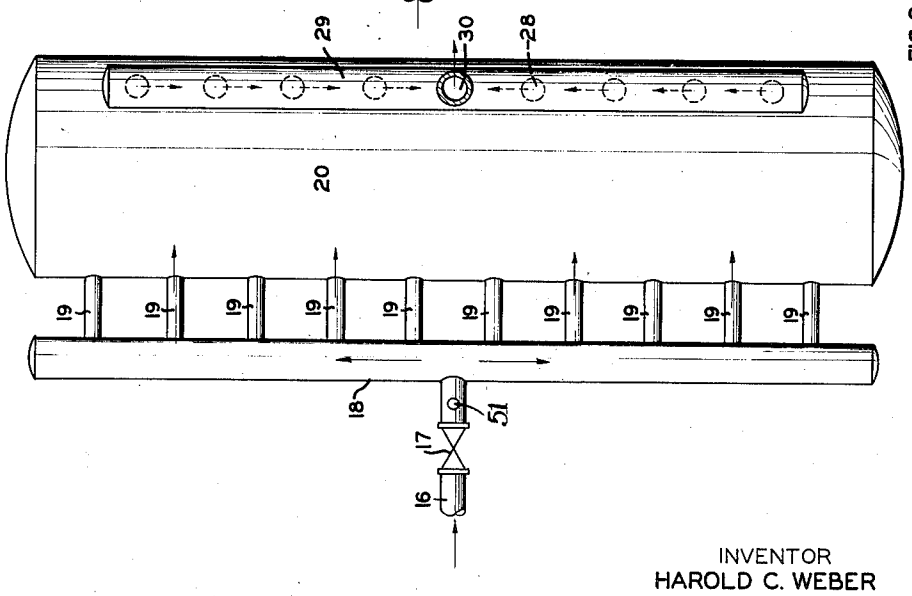


FIG. 2

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UNITED STATES PATENT OFFICE

2,074,196

HYDROCARBON OIL CONVERSION

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Application January 6, 1932, Serial No. 584,942

3 Claims. (Cl. 196—65)

This invention relates to the conversion of relatively high boiling hydrocarbon oils into substantial quantities of more desirable products of lower boiling ranges, and more particularly relates to a process wherein reaction temperature and time is so controlled that increased yields of desirable products for a given gas loss are realized, or the same yield of desirable products for a lower gas loss.

By the use of our process we are able to employ relatively high conversion temperatures without causing the gas losses which normally accompany high temperature cracking, and so may derive the benefits of high temperature cracking, such as high conversion rates and a light distillate product high in antiknock value and suitable for sale as premium motor fuel.

We have found that the excessive production of gas usually accompanying cracking processes employing temperatures in the range of 925° to 1050° F. or thereabouts is due primarily to too long a time of exposure of the hydrocarbon to the cracking temperature.

We have also found that aside from the time and temperature relationship the pressure employed has a separate effect thus, where the relation between temperature and time is comparable for two runs at different pressures, the quantity of gasoline produced in each run would be substantially the same, however, the amount of non-condensable gas produced in the run under lower pressure is much greater than that produced in the run under increased pressure. Our process, therefore, preferably employs pressures higher than those ordinarily used in high temperature cracking, and in order to maintain the proper relationship between time and temperature we provide means for controlling both of these variables.

We may use any of the well known methods of controlling the reaction temperature and may further provide a novel means of generating a portion of the heat required for conversion by the direct selective combustion of a portion of the hydrocarbon material undergoing treatment, and more particularly combustion of the carbon and tar-like bodies formed during the cracking reaction. We may also control the temperature in the zone of direct combustion by introducing cooling material, such as raw oil charging stock for the process, into direct contact with the heated oil about to be mixed with the combustion supporting gases. By introducing a sufficient quantity of cooling material into the products leaving the direct combustion zone we may also control the time of reaction. Also other means of controlling reaction time, such as properly proportioning the sizes of the reaction zone, may be utilized.

In the drawings, Fig. 1 is a diagrammatic side elevational view of one form of apparatus in which the process of the invention may be practiced and which embodies the improvements provided by the present invention.

Fig. 2 is an enlarged diagrammatic plan view of the direct combustion zone which is a part of the apparatus of Fig. 1.

Fig. 3 is a still further enlarged diagrammatic transverse sectional view through the direct combustion chamber illustrated in Fig. 2.

Referring to the attached Fig. 1: Raw oil introduced through line 1 and valve 2 to pump 3 may be fed through line 4 and valve 5 into line 6 and thence through heating element 14, or may be fed through line 7 and valve 8 into fractionator 9, where it is preheated by direct contact with the ascending vapors, the fractionation of which is thereby assisted, and may pass together with the reflux condensate through line 10 and valve 11 to pump 12 and thence through line 6 and valve 13 into the aforementioned heating element 14.

Heating element 14 is located in any suitable form of furnace 15 and the oil passing through this heating element may be subjected to any desired temperature under the desired pressure conditions and may thence pass through line 16 and valve 17 into manifold 18, from whence it passes through a plurality of lines 19 into direct combustion zone 20, where it may be further heated by introducing air or other combustion supporting materials through line 22 and valve 23 to manifold 24 and thence through a plurality of lines 25 into zone 20, whereupon additional heat is generated and the temperature of the oil increased by combustion of coke and tar-like bodies deposited from the heated hydrocarbons undergoing conversion and also a portion of the hydrocarbons themselves, if desired, as will be more fully described later. Drips may collect within zone 20 at the start and finish of the run and during other abnormal periods and may be removed through line 26 controlled by valve 27. Vapors may be removed from zone 20 through a plurality of lines 28 and manifold 29, thence through line 30 controlled by valve 31 into reaction chamber 32.

Unvaporized residuum may be withdrawn from chamber 32 through line 35 controlled by valve 36. This residuum may be passed for ex-

ample to a flashing chamber or to a coking retort, neither of which is illustrated, or to cooling and storage.

Vapors from chamber 32 pass through line 33 and valve 34 to dephlegmator 9, where they are subjected to fractionation, and the heavier fractions condensed and returned through line 10 and valve 11 to pump 12, and thence to the heating zone as already described.

Fractionated vapors from dephlegmator 9 pass through line 37 and valve 38 to condenser 39, thence through line 40 and valve 41 to receiver 42, wherein the pressure on the system is controlled by releasing excess quantities of gas through line 45 and valve 46. The distillate may be withdrawn from receiver 42 through line 43 controlled by valve 44, and a portion of it may, if desired, be returned to the upper part of dephlegmator 9 in the usual manner, not here illustrated, to assist fractionation.

Referring now to Figs. 2 and 3, which are respectively a plan view, and a cross sectional view, of direct combustion zone 20; heated hydrocarbons introduced through line 16 and valve 17 to manifold 18 are fed into combustion zone 20 through a plurality of nozzles 19. These heated hydrocarbons impinge upon a porous refractory plate 21 within combustion zone 20. Material such as air, steam or mixtures thereof introduced through line 22 and valve 23 to manifold 24 are injected through a plurality of lines 25 into chamber 20 below the porous refractory plate 21. Sufficient pressure is maintained on these combustion supporting gases to force them through the perforations or porous openings in plate 21. This oxidizing material effects a selective oxidation of coke and other heavy carbonaceous material deposited on the upper side of plate 21 and, if desired, may be introduced in sufficient quantity to effect the selective combustion of a portion of the hydrocarbon vapors within said chamber. A drain pipe 26 controlled by valve 27 is provided to remove any drips which may collect in the bottom of the chamber. Hydrocarbon vapors and combustion products at the attained temperature are removed from chamber 20 through a plurality of vapor lines 28 into manifold 29, and thence through line 30 controlled by valve 31 to further treatment such as illustrated in Fig. 1.

It will be apparent that many different structural forms as well as modifications of the form shown may be employed as a direct combustion zone, for example, the plate 21 may have various curved surfaces or a substantially flat surface and may be of porous refractory material, high temperature metallic alloy with suitable perforations, or any other material suitable for the purpose.

Referring again to Fig. 1 the temperature in combustion zone 20 may also be regulated by admitting suitable cooling material, such as raw oil charging stock through line 51 and valve 52 into line 16, where it is mixed with the hot oil issuing from heating coil 14, the resulting mixture then passing through manifold 18, pipes 19 into zone 20, where it is treated in the manner already described.

The time of the reaction may also be controlled by passing cooling material such as raw oil charging stock from line 51 through line 47 and valve 48 into line 30 where it may cool the hot hydrocarbon vapors and combustion gases passing to the reaction chamber.

It is also obvious that cooling material may be injected into various other parts of the system in order to decrease the rate of reaction taking place therein, or terminate said reaction altogether.

Pressures ranging from substantially atmospheric up to 2000 pounds or more per square inch may be employed within the system, and may be substantially equalized throughout the system, or differential pressures may be employed between the various elements. Reaction temperatures may range from 700° to 1400° F., more or less. Preferably, the temperature of the material discharged from heating element 14 is substantially increased in combustion zone 20, and is maintained at a lower temperature in chamber 32, this latter temperature may even be below that at which cracking takes place.

As an example of specific operating conditions and yields which may be obtained by our process operated at a temperature of approximately 1000° F. in the vapors leaving the direct combustion zone, and with a substantially uniform pressure of 200 pounds per square inch throughout the system, a yield of approximately 55% of gasoline having an antiknock value equivalent to a blend of 50% benzol and 50% straight run Pennsylvania gasoline or approximately 65% isooctane in admixture with normal heptane may be obtained. Using air as the oxidizing agent in the combustion zone, the resulting distillate shows an appreciable quantity of alcohols and other oxidation products.

This application is a continuation in part of our copending application Serial No. 463,890, filed June 26, 1930, now U. S. Patent 1,960,608.

We claim as our invention:

1. A hydrocarbon oil cracking process which comprises passing the oil in a restricted stream through a heating zone and heating the same therein to cracking temperature, discharging the heated oil into a combustion zone and separating vapors from residuum therein, depositing upon a porous partition in the combustion zone the carbon and tar-like bodies formed by the cracking of the oil, injecting air into the deposited carbon and tar-like bodies through said partition during the cracking operation to effect combustion thereof and to supply additional heat to the oil undergoing cracking, controlling the temperature in the combustion zone by admixing a cooling medium with the heated oil discharging from the heating zone into the combustion zone, removing the mixture of vapors and gases from the combustion zone and recovering the desired cracked products therefrom by dephlegmation and condensation.

2. A hydrocarbon oil cracking process which comprises passing the oil in a restricted stream through a heating zone and heating the same therein to cracking temperature, discharging the heated oil into a combustion zone and separating vapors from residuum therein, depositing in the combustion zone the carbon and tar-like bodies formed by the cracking of the oil, injecting air into the deposited carbon and tar-like bodies during the cracking operation to effect combustion thereof and to supply additional heat to the oil undergoing cracking, controlling the temperature in the combustion zone by admixing a cooling medium with the heated oil discharging from the heating zone into the combustion zone, removing the mixture of vapors and gases from the combustion zone and abruptly cooling the same to below cracking temperature by the injection of additional cooling medium thereto, and then re-

covering the desired cracked products from the cooled mixture of vapors and gases by dephlegmation and condensation.

3. A hydrocarbon oil cracking process which comprises passing the oil in a restricted stream through a heating zone and heating the same therein to cracking temperature, discharging the heated oil into a combustion zone and separating vapors from residuum therein, depositing in the combustion zone, upon a porous partition having capillary passages, the carbon and tar-like bodies formed by the cracking of the oil, injecting air into the deposited carbon and tar-like bodies through said partition during the cracking operation to effect combustion thereof and to supply additional heat to the oil undergoing cracking, removing the mixture of vapors and gases from the combustion zone and recovering the desired cracked products therefrom by dephlegmation and condensation.

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