

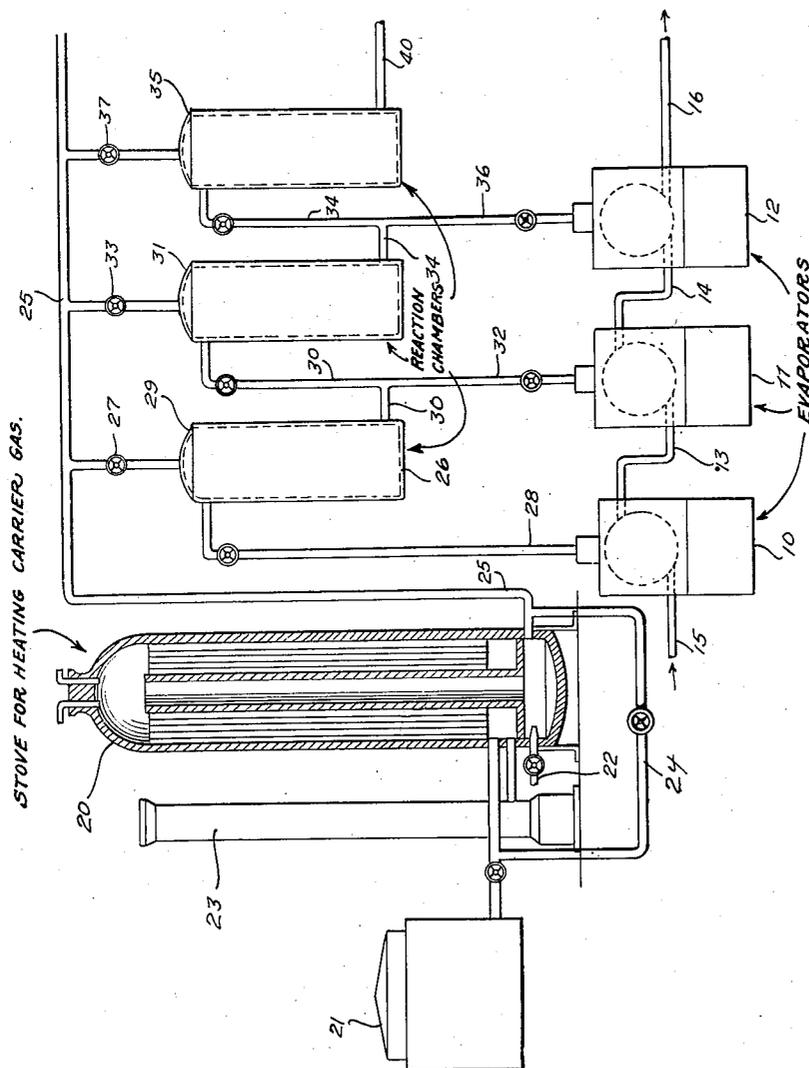
Dec. 25, 1934.

E. W. BEARDSLEY ET AL

1,985,233

PROCESS AND APPARATUS FOR CONVERTING HYDROCARBON OILS

Filed Oct. 6, 1928



INVENTORS
EDWIN W. BEARDSLEY & ALBERT P. SACHS
BY
Sydney G. Berry
ATTORNEY

UNITED STATES PATENT OFFICE

1,985,233

PROCESS AND APPARATUS FOR CONVERTING HYDROCARBON OILS

Edwin W. Beardsley, Texas City, Tex., and Albert P. Sachs, New York, N. Y., assignors to Petroleum Conversion Corporation, New York, N. Y., a corporation of Delaware

Application October 6, 1928, Serial No. 310,866

6 Claims. (Cl. 196—61)

The present invention relates to a process of converting hydrocarbon oils, for example, those of petroleum origin, into compounds having a predominantly lower molecular weight and particularly into those compounds within the gasoline range. In the system of conversion to which our invention is particularly adapted, the oil material is previously vaporized and is converted while in the vapor phase. As is well known, oils commonly used for cracking are not single compounds but mixtures of many compounds each having a different boiling point. When the vapors of these various components of the oil are cracked it is found that not all of them crack with the same ease, those having a relatively low boiling point being found to be considerably more refractory to conditions of cracking than those of higher boiling point. Thus, if the vapors of all the components are subjected to the same conversion temperature, then it is found that the light vapors require a longer period for cracking than the heavier vapors.

The invention accordingly seeks to take advantage of this fact by first fractionally vaporizing the oil to be converted, separately conducting the different fractions, separated by a desired difference in boiling point, to the cracking or conversion zone, and there maintaining the conversion conditions such that the more refractory vapors are subjected to longer periods of cracking. While not limited to this form of heating, the invention contemplates carrying out the conversion by means of a heat carrier gas of suitable temperature and heat units mingled with the vapors undergoing conversion and accordingly in the preferred embodiment the various oil vapor fractions are admitted to a stream of carrier gas of the requisite temperature and heat units at separated points therein whereby the more refractory vapors are caused to pass over a longer course whereas the less refractory vapors pass over a shorter course. In this manner a selective heating of the vapors of the oil components is had whereby a considerably greater control of the conversion conditions is possible and a much greater economy of heat effected. Preferably also, although not necessarily, means are provided whereby the temperature of the stream of products in the cracking zone may be more or less accurately controlled at different points therein and in the embodiment described, this is accomplished by also admitting portions of the carrier gas to the cracking zone at such separated points along the path of the travel of the mixture undergoing conversion.

The invention will be best understood by reference to the following detailed description taken with the accompanying drawing in which we have illustrated more or less diagrammatically an apparatus for carrying out the invention as stated in the foregoing.

In said drawing, 10, 11, and 12 denote evaporators which may be of conventional type heated by means not shown in detail, the same being joined in series by conduits 13 and 14, and evaporator 10 being provided with a conduit 15 by means of which the oil enters the system while evaporator 12 is provided with an exit pipe 16 through which the residue from the still 12 is removed. The oil to be evaporated enters the system through pipe 15, is partially vaporized in evaporator 10 after which the oil minus its lightest vapors is conveyed by pipe 13 to evaporator 11 where a somewhat heavier fraction is vaporized after which the oil passes to evaporator 12 in which the heaviest vapors are produced. As is customary in the art, the evaporation may be aided by the use of steam, or neutral gases or both of these.

Preferably little or no cracking is carried out in the evaporators 10, 11 and 12. For accomplishing the conversion of the oil we preferably make use of carrier gases of the requisite temperature and which are heated preferably by means of regenerative heaters, for example of the hot blast stove type, one of which is indicated at 20. Stove 20 is first heated up by the combustion of fuel which is fed to a burner 22. When the stove is at the requisite temperature, the heating is discontinued, the products of combustion purged therefrom and the stove "run" by passing therethrough the carrier gas from the container 21 which is thus heated to substantially the temperature of the stove. As a means of obtaining a supply of gas of uniform temperature, we preferably provide, as is common in the art, a valved by-pass 24 which admits a regulated quantity of the cold gas to the uptake conduit 25 through which the hot gas is led from the stove. The gas at the desired temperature, for example in the neighborhood of 1400° F., is led from the stove through said conduit 25 to a reaction chamber 26, being admitted thereto through a valve 27. Also admitted to said chamber is vapor from the still 10 which is connected to said chamber by means of a valved pipe 28. The heated gaseous carrier and oil vapor mingle in the said chamber 26. In this chamber the vapor is partially converted. The mixture of reaction products leaves the chamber 26 through conduit 30 through which it is conducted to a second reaction chamber 31. At this point

the stream of products is added by the vapor from the evaporator 11 which passes therefrom through a valved pipe 32 connecting with a conduit 30. The augmented stream of reaction products now traverses the reaction chamber 31 where further time is given for the conversion to take place. As a means for controlling the temperature therein we provide a connection 33 to said chamber from the main 25 conducting the carrier gas from the stove 20, said connection also being valved as shown. The products leaving chamber 31 pass through a conduit 34 to a third reaction chamber 35 being similarly augmented by the vapor from evaporator 12 which passes therefrom through a conduit 36 joining conduit 34. A connection 37 thereto from the carrier gas main 25 is also preferably provided. The final mixture of cracked vapors and carrier gas now leaves the reaction chamber 35 through a conduit 40 by means of which it is passed to suitable heat transfer and condensing means not shown.

It will be seen from the foregoing that the vapor products from the stills or evaporators 10, 11 and 12 which are of increasing molecular weight are thus subjected to periods of cracking or conversion which vary inversely with their molecular weight. While only three evaporators and three reaction chambers are shown, it will be understood that this number is arbitrary and that the number may be increased or even reduced to two, depending upon the circumstances in any given case. Furthermore it is not imperative that separate reaction chambers be employed at each stage so long as the proper time element is allowed, and if desired, one chamber only may be provided having staged inlets for the admission of the vapor to be converted. It will also be evident that by virtue of the carrier gas introduced at each of the reaction chambers or inlet points that a further control of the reaction products is had. It will be further understood that if desired such gas may be introduced at points other than those shown as for example by having more than one connection for each reaction chamber but at spaced points in the path of travel to the reacting products.

A further advantage of the improved process resides in the fact that, with respect to the majority at least of vapors undergoing the conversion, means are afforded for the reheating of such vapors whereby the temperature variation throughout the conversion zone may be greatly reduced. If it were not for the reheating steps, for example, either the initial temperature of the carrier would have to be given too high a value in order to maintain the desired average temperature or an excessive amount of the carrier gas would have to be used in the first conversion chamber. In the instant process the temperature of the vapors is preferably maintained without substantial variation over a relatively long time interval, this making for greater efficiency and better control of the product.

It will be further understood that in the ordinary case, the oil vapor fed to the first conversion chamber, although relatively of low molecular weight will nevertheless be higher than that desired in the final product although it might be desired to treat even vapors of the gasoline range, for example, in this manner for the sake of improving their anti-knock qualities.

What we claim is:

1. In the process of converting hydrocarbon oils, the steps which consist in producing a stream of heated heat-carrier gas of substantially uni-

form temperature, utilizing said stream to establish a reaction zone, vaporizing said hydrocarbon oil to be converted in a plurality of evaporating zones distinct from said reaction zone in such a manner as to produce a plurality of streams of oil vapor of graduated boiling point range, mingling the stream of the lightest vapor with said carrier gas in said reaction zone, wherein the heat in said gas initiates the conversion of said vapor at the desired conversion temperature, then successively adding to said stream in successive reaction zones said other vapor streams in such a manner that the heavier fractions are subjected to conversion conditions for a less period of time, but are subjected to substantially the same temperature as said lighter fractions.

2. In the process of converting hydrocarbon oils, the steps which consist in producing a stream of heated heat-carrier gas of substantially uniform temperature, utilizing said stream to establish a reaction zone, vaporizing said hydrocarbon oil to be converted in a plurality of evaporating zones distinct from said reaction zone in such a manner as to produce a plurality of streams of oil vapor of graduated boiling point range, mingling the stream of the lightest vapor with said carrier gas in said reaction zone, wherein the heat in said gas initiates the conversion of said vapor at the desired conversion temperature, then successively adding to said stream in successive reaction zones said other vapor streams in such a manner that the heavier fractions are subjected to conversion conditions for a less period of time and regulating the temperature at each of said successive reaction zones by adding a graduated quantity of said heated carrier gas to each zone.

3. In the process of converting hydrocarbon oils, the steps which consist in producing a stream of heated heat-carrier gas of substantially uniform temperature, utilizing said stream to establish a reaction zone, vaporizing said hydrocarbon oil to be converted in a plurality of evaporating zones distinct from said reaction zone in such a manner as to produce a plurality of streams of oil vapor of graduated boiling point range, mingling the stream of the lightest vapor with said carrier gas in said reaction zone, wherein the heat in said gas initiates the conversion of said vapor at the desired conversion temperature, then successively adding to said stream in successive reaction zones said other vapor streams in such a manner that the heavier fractions are subjected to conversion conditions for a less period of time and bringing the temperature of the produced mixture in each of said zones to substantially that of said conversion temperature of said first reaction zone by adding graduated quantities of said heat-carrier gas to said zones.

4. In the process of converting hydrocarbon oils, the steps which consist in producing a stream of heated heat-carrier gas of substantially uniform temperature, utilizing said stream to establish a reaction zone, separating the oil to be converted into a plurality of vapor fractions of graduated boiling point range, mingling the stream of the lightest vapor with said carrier gas in said reaction zone, wherein the heat in said gas initiates the conversion of said vapor at the desired conversion temperature, then successively adding to said stream in successive reaction zones said other vapor streams in such a manner that the heavier fractions are subjected to conversion conditions for a less period of

time and regulating the temperature at each of said successive reaction zones by adding a graduated quantity of said heated carrier gas to each zone.

- 5 5. In an apparatus for converting hydrocarbon oil, in combination, a source of heat-carrier gas, conversion apparatus proper consisting of a plurality of reaction chambers in series, a plurality of vaporizing units separate from said source of heat-carrier gas, said units being heated independently of said reaction chambers and adapted to furnish vapors of varying boiling point, means for feeding oil thereto, means for conducting vapor from each of the respective vaporizing units to each of said reaction chambers such that said unit producing the lightest vapors is joined to the first of the said reaction chambers in series, while the vaporizing unit producing the heaviest vapor is joined to the last of said reaction chambers in series, means for admitting heat-carrier gas to the first of said chambers and means for admitting a regulated supply of said gas to each of said subsequent chambers for the purpose of controlling the temperature thereof.
- 10 20 25 6. In an apparatus for converting hydrocarbon oil, in combination, a source of heat carrier

gas, a conversion apparatus proper, a plurality of vaporizing units separate from said source of heat-carrier gas, means for passing oil through said vaporizing units in series, means for conducting vapors from the first vaporizing unit of the series to the inlet end of the conversion apparatus, means for conducting vapors from the succeeding vaporizing units to successive spaced points in the conversion apparatus in the direction of the outlet end of said conversion apparatus, said points being so spaced as to provide a substantial time differential in respect to the flow of vapors through said conversion apparatus, the arrangement being such that said unit producing the lightest vapors is joined to said inlet end of the conversion apparatus and said unit producing the heaviest vapors is joined to said conversion apparatus nearest the outlet end thereof, means for admitting a regulated supply of heat-carrier gas to spaced points between the inlet and outlet ends of the conversion apparatus, and heating means for said vaporizer units independent of the heating means for the conversion apparatus.

5 10 15 20 25

EDWIN W. BEARDSLEY. 25
ALBERT P. SACHS.