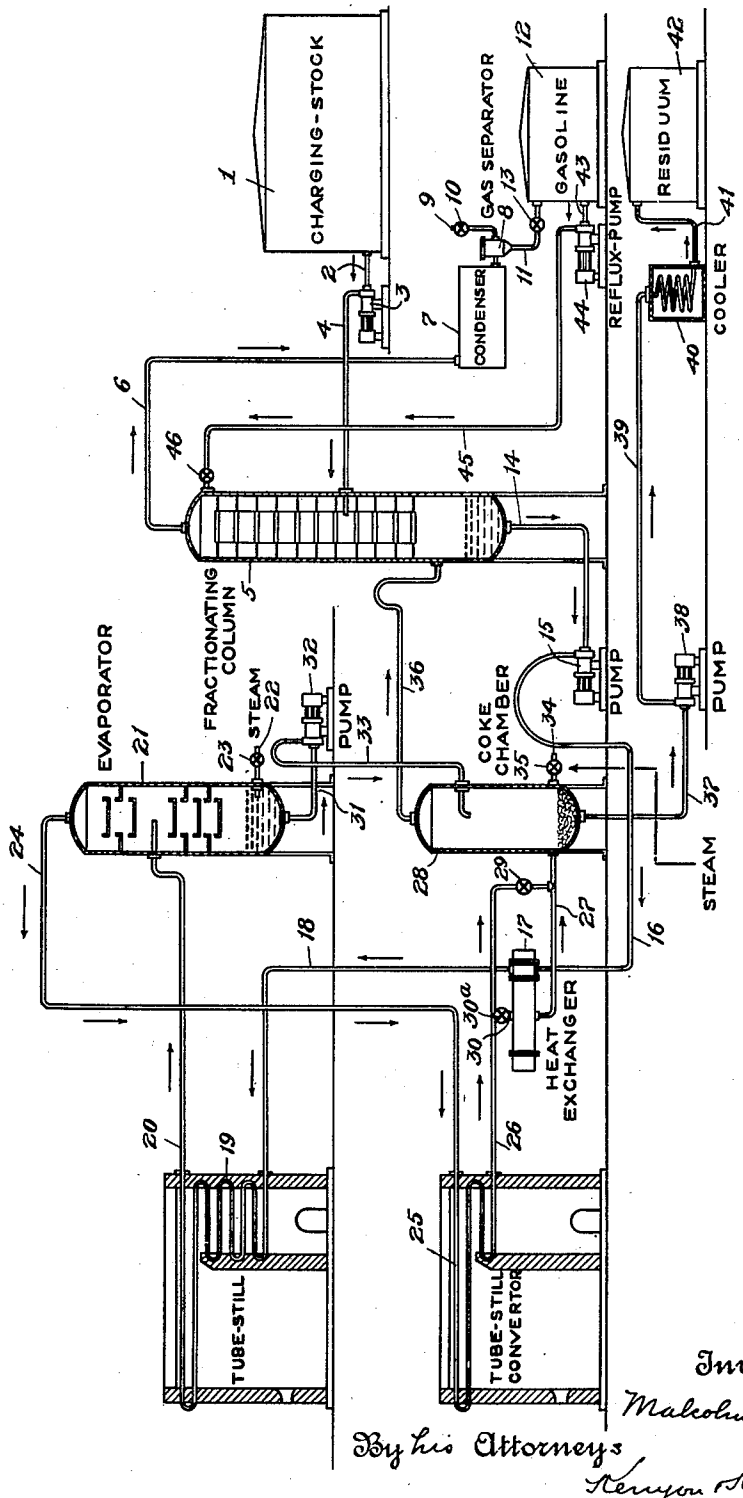
Aug. 10, 1937. M. H. TUTTLE 2,089,511.

GASOLINE PRODUCTION

Filed Aug. 7, 1929



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Patented Aug. 10, 1937

2,089,511

UNITED STATES PATENT OFFICE

2,089,511

GASOLINE PRODUCTION

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Application August 7, 1929, Serial No. 384,030

3 Claims. (Cl. 196—61)

This invention relates to the production of gasoline by cracking.

An object of this invention is an improved process of, and apparatus for, obtaining gasoline from petroleum oil by cracking, wherein cracked vapors are contacted with the high boiling fractions of the charging stock to remove the volatile constituents of such stock, thereby obtaining the maximum yield of gasoline and reducing the charging stock to coke or heavy tar residue.

According to this invention the low boiling constituents of the charging stock are vaporized therefrom by contact with vaporized cracked hydrocarbons and gasoline is separated from the vapor mixture thus obtained by fractionation. The condensed cracked hydrocarbons form recycle stock, which, together with the unvaporized charging stock is heated and high boiling compounds are vaporized therefrom at an absolute pressure not exceeding 100 pounds per square inch and are subjected to a sufficiently high temperature to promote cracking. The mixture of recycle stock and unvaporized charging stock is preheated by out of contact heat exchange with the cracked vapor and the cracking reaction is arrested by the cooling of the cracked vapors in the heat exchange operation. The cracked vapors are intimately contacted with the unvaporized stock completely to evaporate therefrom the volatile constituents and produce a coke or heavy tar residue and the vapor is then utilized to vaporize the low boiling constituents of the charging stock.

The gasoline obtained in accordance with the invention has high anti-knock value and is very suitable for use in high compression internal combustion engines. The vaporization of the highest boiling point fractions is effected by causing intimate contact between the liquid stock and the cracked hydrocarbon vapors so that the sensible heat of the cracked vapor and the latent heat of the highest boiling point hydrocarbon produced by the cracking reaction are utilized for the final stripping of the volatile constituents of the stock. The major part of the charging stock is vaporized and raised to cracking temperature and the remaining part thereof is evaporated to a coke or heavy tar residue. The higher boiling point hydrocarbons produced as a by-product of the cracking reaction are condensed by contact with the non-vaporized portion of the charging stock to vaporize such fractions. The utilization of heat from the cracked hydrocarbon vapors to effect the final vaporization of the cracked stock increases the amount of gasoline produced.

Heretofore, in the operation of vapor phase cracking systems, heat exchange between the cracked vapors and charging stock has been avoided because of deposition of carbon or coke in the exchanger. Such deposition is due to the condensation of higher boiling point hydrocarbons produced by the cracking reaction, but heat exchange is possible at temperatures above the condensing temperature of the high boiling point hydrocarbons. Upon cooling below this temperature, condensation takes place, which is followed by re-vaporization when a slight rise in temperature occurs. The re-vaporization leaves a coke residue which makes heat conservation by heat exchange impracticable below the condensing temperature. I have discovered that the heat of the cracked vapors can be utilized by direct contact of the vapors with the liquid stock for evaporating the latter to a coke or heavy tar residue in which case the products of condensation of the cracked vapor and the residue from the charging stock are deposited together. By the provision of a chamber for receiving this residue, the remainder of the system may be kept free from coke and because of the complete vaporization of the charging stock by the cracked vapors, the maximum conversion of charging stock will be obtained.

Other objects, novel features and advantages of this invention will be apparent from the following specification and accompanying drawing, wherein one type of apparatus is disclosed for carrying out the process.

The apparatus disclosed provides for recycling the unconverted hydrocarbons thereby obtaining the maximum yield of gasoline. Charging stock is drawn from the tank 1 through the pipe 2 by the pump 3 and is delivered through the pipe 4 to the fractionating column 5. The charging stock in descending through the fractionating column is heated by ascending cracked hydrocarbon vapors produced in the manner subsequently to be described and supplied to the column. The cracked hydrocarbon vapor strips the charging stock of the low boiling constituents which it contains and the vaporization of such constituents cools the ascending cracked hydrocarbon vapors, thereby condensing unconverted high boiling point hydrocarbons to produce recycle stock which is mixed with the non-vaporized portion of the charging stock. The vapor mixture thus obtained is fractionated in the column 5 and the vapors produced are conducted from the column by a pipe 6 through condenser 7 to a gas separator 8 from which the non-condensable gases escape

through the pipe 9 controlled by the valve 10 and the gasoline flows through the pipe 11 to the run-down tank 12, the pipe 11 being provided with a valve 13.

The mixture of recycle stock and non-vaporized charging stock is conducted from the bottom of the fractionating column 5 through a pipe 14 to pump 15 by which it is forced through pipe 16, heat exchanger 17 and pipe 18 to the heating element of the tube still 19 and thence through pipe 20 to an evaporator 21. In the evaporator 21 a portion of the higher boiling constituents of the stock is vaporized and steam may be supplied through the pipe 22 controlled by the valve 23 to assist such vaporization. The vapor produced in the evaporating chamber 21 is conducted by pipe 24 to the heating element of a tube still 25 in which the vapors are raised to conversion temperature. From the conversion still 25, the cracked vapors are conducted through pipe 26 to the heat exchanger 17 in which the vapors are brought into out of contact heat exchange relation with the liquid stock, thereby pre-heating the same and cooling the vapors to a temperature slightly above the temperature of condensation of the highest boiling point fraction thereof. The cooled vapors are conducted from the heat exchanger through pipe 27 to a coke chamber 28. A by-pass pipe 29 leads from the pipe 26 to the pipe 27 and provides a path for cracked vapors to pass directly from the converter 25 to the coke chamber 28. Valves 30 and 30a are provided for controlling the flow of vapor through the pipes.

The cracked hydrocarbon vapors ascend through the coke chamber 28 and the unconverted liquid stock in the evaporator 21 is caused to flow counter-current to the vapors, thus effecting intimate contact between the vapors and the liquid. The liquid stock is conducted from the evaporator 21 through the pipe 31 to the pump 32 by which it is forced through the pipe 33 into the coke chamber 28. Contact between the liquid stock and the cracked vapor effects the vaporization of the volatile constituents of the liquid stock, the sensible heat of the cracked vapor and the latent heat of the high boiling point vapors being utilized to effect the final stripping of the stock. Steam may be supplied to the coke chamber through the pipe 34 controlled by the valve 35 to assist in the vaporization in the chamber. The cooled cracked vapors are conducted through the pipe 36 from the coke chamber to the fractionating column 5 and are caused to flow counter-current to the descending charging stock as previously described. The residue left in the coke chamber may be either tar or coke. The nature of the residue depends upon the extent of the vaporization effected in the coke chamber and this is dependent upon the temperature of the cracked hydrocarbon vapors supplied to the coke chamber. The temperature of such vapors is lower when they are passed through the heat exchanger and under this condition the residue is liquid tar and is conducted from the coke chamber through the pipe 37 to the pump 38 which forces the same through pipe 39, cooler 40 and pipe 41 to the run down tank 42. The temperature of the cracked hydrocarbon vapors conducted directly from the converter still 25 to the coke chamber 28 is sufficiently high that the residue in the chamber 28 is evaporated to dryness thereby forming a coke.

The pressure to which the vaporized hydrocarbons are subjected in the cracking operation is determined by regulation of the valves 10 and 13. The pressure maintained in the system by the valves 10 and 13 preferably does not exceed ten pounds per square inch absolute. The temperature in the fractionating column may be controlled by refluxing gasoline from the low down tank 12 through pipe 43, pump 44, pipe 45 and temperature control valve 46 to the top of the fractionating column 5. Petroleum treated according to this invention yields the maximum amount of gasoline, due to the complete vaporization of the volatile constituents. The coke produced is retained within a chamber provided for that purpose and the remainder of the system is kept free of coke.

It is, of course, apparent that a different apparatus from that disclosed may be utilized for carrying out the process and modifications may be made in the process without in any way differing from the spirit of the invention as defined in the appended claims.

I claim:

1. The method of producing motor fuel from petroleum oil which comprises vaporizing the low boiling compounds therefrom, heating the remainder to vaporize a portion thereof, subjecting the vapor thus obtained to cracking conditions, passing the cracked vapor into heat exchange relation with the remainder from the first vaporizing step to pre-heat the same for the second vaporization step, then into counter-current contact with the remainder from the second vaporization step for completely removing therefrom volatile constituents and forming a coke residue and finally into counter-current flow with fresh oil to effect the first vaporization step, fractionating the mixed vapors thus obtained and condensing the fractionated vapor to produce gasoline.

2. In a cracking system, a fractionator, means to introduce charging stock into said fractionator at an intermediate point, a heater, a vaporizer, means to supply liquid from said fractionator through said heater to said vaporizer, a second heater, a chamber, means to supply vapor from said vaporizer through said heater to said chamber, means to supply liquid from said vaporizer to said chamber, means to conduct vapor from said chamber to said fractionator, a condenser into which vapors are discharged from said fractionator and means to establish heat exchange relation between the vapor flowing from said second heater to said chamber and liquid flowing from said fractionator to said first heater.

3. In a cracking system, a fractionator, means to introduce charging stock into said fractionator at an intermediate point, a heater, a vaporizer, means to supply liquid from said fractionator through said heater to said vaporizer, a second heater, a chamber, means to supply vapor from said vaporizer through said heater to said chamber, means to supply liquid from said vaporizer to said chamber, means to conduct vapor from said chamber to said fractionator, a condenser into which vapors are discharged from said fractionator, means to establish heat exchange relation between the vapor flowing from said second heater to said chamber and liquid flowing from said fractionator to said first heater, and a vapor by-pass around said heater.

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