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ART OF REFINING HYDROCARBONS

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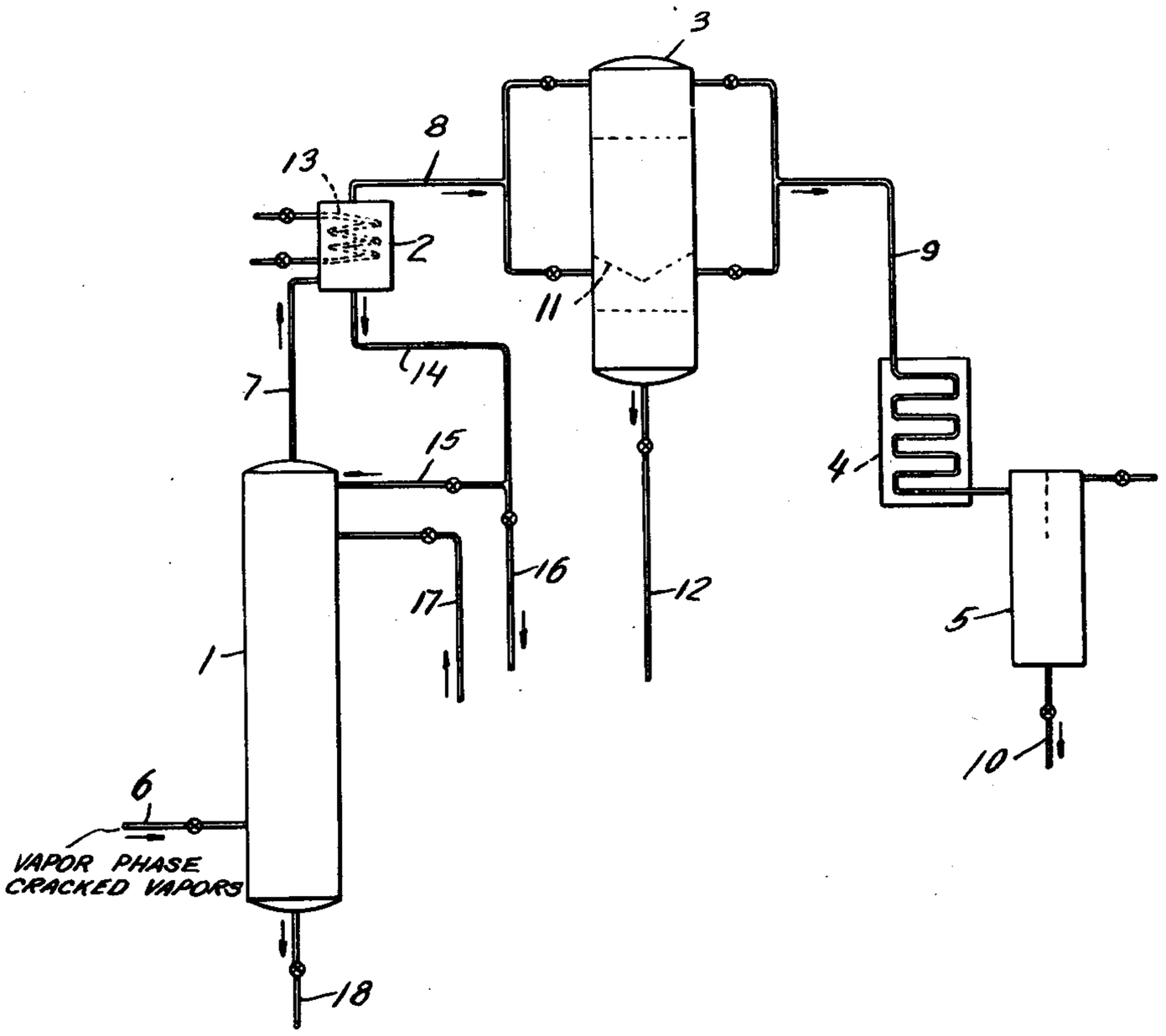

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UNITED STATES PATENT OFFICE

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ART OF REFINING HYDROCARBONS

Application filed September 14, 1928. Serial No. 305,906.

This invention relates to improvements in the manufacture of gasoline; more particularly the invention relates to improvements in the combined vapor phase cracking of oil to produce motor fuel gasoline and refining of the thus produced gasoline by passage through an adsorptive catalyst in vapor phase.

The products of operations in which relatively severe cracking conditions are maintained include, if the conditions are appropriate, constituents of special value as components of motor fuel. With many more refractory stocks, such as kerosene and light gas oil, the more advantageous range of cracking temperatures lies above the critical temperature of this stock so that the operation must be carried out substantially in the vapor phase if such relatively severe cracking conditions are maintained. With heavier and higher boiling stocks, such as heavy gas oil, the more advantageous range of cracking temperatures may not lie wholly above the critical temperature of the stock but even in such cases the pressures necessary to maintain any substantial part of the stock in liquid phase are usually extremely high. This invention relates particularly to combined operations in which oil is heated in the vapor phase to a high cracking temperature, that is to a cracking temperature upwards of 900° F.

These constituents of special value as components of motor fuel are unsaturated and, in raw cracked gasoline so produced, are associated with other unsaturated constituents such as the di-olefines which are not suitable as components of motor fuel. When such raw cracked gasoline is passed in vapor phase through an adsorptive catalyst such as fuller's earth, these objectionable unsaturated constituents are selectively polymerized to form higher boiling polymers. This reaction thus affords a means of separating such objectionable unsaturated constituents without involving loss of other unsaturated constituents of special value as components of motor fuel.

In the manufacture of gasoline containing these unsaturated constituents of special value as components of motor fuel, it has previously been proposed to subject the raw cracked vapors from the vapor phase cracking operation first to a fractionating operation and then to pass the vapors escaping from the fractionating operation through an adsorptive catalyst to effect the polymerization of objectionable unsaturated constituents. This fractionating operation has usually been carried out for either or both of two purposes; to separate from the raw cracked vapors for return to the cracking operation constituents higher boiling than suitable as components of the gasoline product but suitable again to be subjected to the cracking operation, and to separate from the raw cracked vapors all constituents higher boiling than suitable as components of the gasoline product to produce directly a gasoline of the desired boiling range. Irrespective of purpose, it has been common practice to control such fractionating operations by introducing directly into the vapors in the fractionating operation a part of the final gasoline product.

This scheme of operation has several advantages so far as effecting or promoting accurate fractionation of the vapor mixture subjected to the fractionating operation is concerned, but in combined vapor phase cracking and vapor phase refining operation in which the raw cracked vapors are passed successively through the fractionating operation and then through an adsc.ptive catalyst it has a number of disadvantages. In carrying out this scheme of operation, that part of the final gasoline product reintroduced into the vapors in the fractionating operation is revaporized therein and again contacted with the adsorptive catalyst in admixture with the vapors escaping from the fractionating operation, and this returned part of the final gasoline product is thus subjected to repeated contact with the adsorptive catalyst. This repeated contact usually involves severe and excessive losses, apparently due to the instability of unsaturated constituents of the cracked product, and these losses are doubly severe because they usually constitute a loss of unsaturated constituents of special value as components of motor fuel.

This invention provides an improved method of operation which, although providing for accurately controlled fractionation in this combined vapor phase cracking and vapor phase refining operation, eliminates such losses, and which has several further important advantages.

According to the present invention, in combined vapor phase cracking and vapor phase refining operations in which the raw cracked vapors are passed successively through a fractionating operation and then through an adsorptive catalyst, a partial condensate is produced from the vapors escaping from the fractionating operation before they contact with the adsorptive catalyst by indirect heat exchange with a cooling medium, such as water or such as raw oil to be supplied to the cracking operation proper, and the fractionating operation is controlled by introducing this condensate into direct contact with the vapors in the fractionating operation. The invention thus affords accurate control of the fractionating operation and at the same time avoids recontacting with the adsorptive catalyst in the refining operation any part of the final gasoline product condensed from the vapors escaping from the fractionating operation which have been subjected to the refining operation.

The invention will be further described in connection with the accompanying drawings which illustrate, in a diagrammatic and conventional manner, one form of apparatus adapted for carrying out the process of invention, but it is intended and will be understood that this further description and illustration are for the purpose of exemplification only.

Referring to the drawing, the apparatus illustrated includes a fractionating tower 1, a condenser 2, a refining tower 3, another condenser 4, and a receiver 5. Raw cracked vapors from the apparatus in which the vapor phase cracking operation proper is carried out are supplied to the lower end of tower 1 through connection 6, vapors escaping from the upper end of tower 1 are conveyed to the condenser 2 through connection 7 and vapors escaping from the condenser 2 are conveyed to the refining tower 3 through connection 8, vapors escaping from the refining tower 3 are conveyed through connection 9 to the condenser 4, and, after separation from any uncondensed vapors and gases in the receiver 5, the condensate produced in condenser 4 is discharged through connection 10. A charge of an adsorptive catalyst, 40–60 or 60–80 mesh fuller's earth for example, is supported upon a foraminous partition 11 in the refining tower 3. The vapors to be subjected to the refining operation may be passed either upwardly or downwardly through this charge of the adsorptive catalyst by means of the branch connections shown. Polymers produced by the vapor-catalyst contact and other high boiling material separated in the tower 3 are discharged through connection 12. A suitable cooling medium is circulated at an approximately regulated rate through the cooling coil 13 in the condenser 2. Connections 14 and 15 are provided for introducing the partial condensate produced in condenser 2 into the upper end of tower 1; a part of this condensate may also be discharged through connection 16. Another refluxing agent, for example raw oil to be supplied to the cracking operation proper where the condensate mixture produced in the fractionating tower is returned to the cracking operation, may also be introduced into the tower 1 at an intermediate point through connection 17. The condensate or condensate mixture produced in the tower 1 is discharged through connection 18.

The apparatus illustrated may be connected directly to a vapor phase cracking apparatus such as that described in an application filed June 13, 1927, by Harry L. Pelzer, Serial No. 198,621. For example the vapor mixture escaping from the scrubbing tower or from a subsequent reflux tower or fractionating tower in that apparatus may be supplied to tower 1 through connection 6 and the condensate or condensate mixture discharge from tower 1 through connection 18 may be supplied to the heater or to the upper end of the scrubbing tower or to the upper end of a subsequent reflux tower or refractionating tower in that apparatus.

In carrying out the present invention in the apparatus illustrated, the raw cracked vapors from the vapor phase cracking operation are passed successively through the fractionating tower 1 and then through the charge of the adsorptive catalyst in the refining tower 3 and the fractionating operation carried out in the fractionating tower 1 is controlled by introducing directly into the upper end of this fractionating tower a partial condensate produced in condenser 2 from the vapors escaping from the upper end of the fractionating tower 1 before they contact with the adsorptive catalyst in the refining tower 3. This control may be effected, for example, by regulating the rate of circulation of the cooling medium through the cooling coil 13 so that this partial condensate is produced from the raw vapor mixture at a rate not less than the maximum rate at which this condensate is required to be supplied to the fractionating operation and by regulating, by means of the valves in connections 15 and 16, the proportion of this condensate introduced directly into the upper end of the fractionating tower 1 through connection 15 and the proportion discharged through connection 16. Or, for example, this control may be effected by regulating the

rate of circulation of the cooling medium or the temperature of the cooling medium circulated through the cooling coil 13, or by regulating this rate or this temperature conjointly with regulation of the proportion of the partial condensate supplied to the fractionating operation through connection 15 and discharged through connection 16.

The fractionating operation preceding the refining operation, the fractionating operation carried out in tower 1 of the apparatus illustrated for example, may be controlled so that the vapors escaping from the refining operation when condensed form a final refined gasoline product of the desired boiling range, or the fractionating operation preceding the refining operation, the refining operation carried out in tower 1 in the apparatus illustrated for example, may be controlled so that the vapor mixture escaping from the refining operation includes only 50–75%, for example, of the desired gasoline product and this vapor mixture may then be subjected to a further fractionating operation controlled to produce a final gasoline product of the desired boiling range. The refining operation may be combined with a subsequent fractionating operation, for example, as described in my application filed February 29, 1928, Serial No. 257,958.

I claim:

In combined vapor phase cracking and vapor phase refining operations in which the raw cracked vapors are passed successively through a fractionating operation and then through an adsorptive catalyst, the improvement which comprises producing a partial condensate from the vapors escaping from the fractionating operation before they contact with the adsorptive catalyst by indirect heat exchange with a cooling medium, introducing this condensate into direct contact with the vapors in the fractionating operation, and controlling the fractionating operation by independently regulating the amount of condensate thus introduced thereto.

In testimony whereof I affix my signature.

EUGENE C. HERTHEL.