

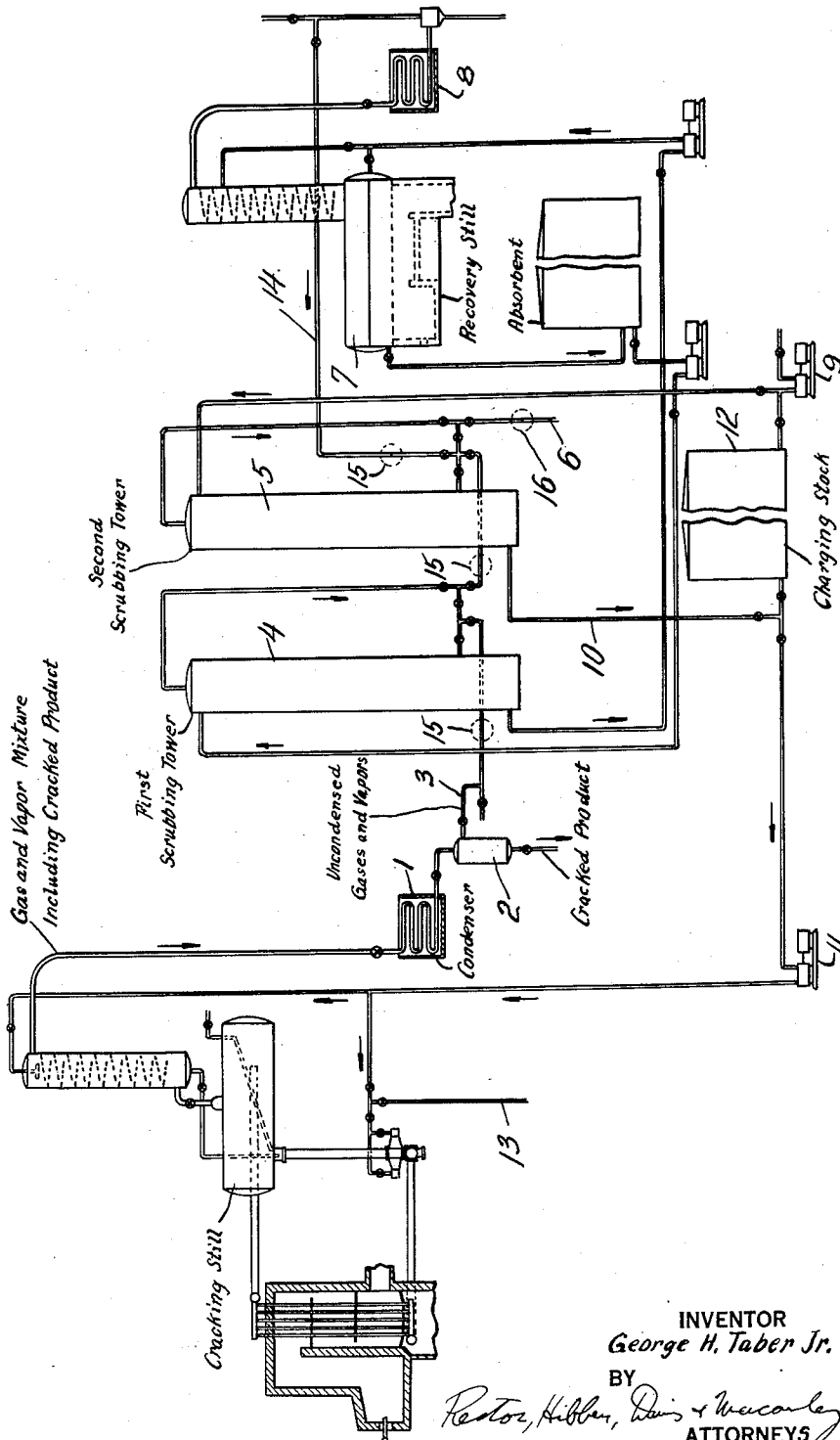
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ART OF CRACKING HYDROCARBONS

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UNITED STATES PATENT OFFICE.

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ART OF CRACKING HYDROCARBONS.

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This invention relates to improvements in operations carried out to produce lighter and lower boiling hydrocarbon oils, such as gasoline and pressure distillate, from heavier and higher boiling hydrocarbon oils, such as kerosene, gas oil, fuel oil and the like, particularly by distillation under superatmospheric pressure. The invention is useful, however, in connection with other types of operations, such as those in which the oil to be cracked is heated to a cracking temperature in the vapor phase at either approximately atmospheric pressure or at higher pressures and processes in which the oil is heated to a cracking temperature, usually under very high pressures, without complete separation of vapors and unvaporized liquids in the cracking operation itself.

In cracking operations in which the cracked products are taken off as a mixture of vapors and gases, either from the cracking operation itself or from some subsequent operation carried out to separate the lighter cracked products from residues the constituents of which are unsuitable as components of the desired product, the mixture usually includes vapors of the desired lighter and lower boiling hydrocarbon oils, gases incondensable except under high pressures and at low temperatures, and constituents in gas or vapor form of an intermediate character. These intermediate constituents usually include both saturated and unsaturated components. Hydrogen and methane may be mentioned as examples of the incondensable gases, and ethylene and the related unsaturated hydrocarbons as examples of the unsaturated intermediate constituents. In the usual condensing operation, a certain amount of the constituents suitable as components of the desired product are carried off uncondensed with the incondensable gases, and the difficultly condensable intermediate constituents, or part of them, also escape in this same way. The recovery of the condensable constituents suitable as components of the desired product is of course desirable to improve the yield secured from the operation, and the return of the intermediate constituents, particularly the unsaturated components thereof, likewise assists in improving the efficiency and the yield secured in operation.

Hitherto it has been customary to subject

such gas mixtures escaping from condensing operations employed in connection with cracking operations to a scrubbing operation with some absorbent medium from which the condensable hydrocarbons are subsequently separated and recovered, for example by distillation from the absorbent. Likewise, these gas mixtures have previously been subjected to scrubbing operations with fresh stock to be supplied to the cracking operation so that absorbable constituents are separated and returned to the cracking operation whence they again escape with the gas and vapor mixtures including the desired product.

According to the present invention, the gas and vapor mixture remaining uncondensed after the gas and vapor mixture from the cracking operation has been subjected to condensation is first subjected to treatment with an absorbent for the separation of the more easily condensable constituents such as those suitable as components of the desired product and then to treatment with fresh stock to be supplied to the operation. The constituents separated from the gas and vapor mixture in the first absorbent treatment are recovered from the absorbent, for example, by distillation, and the denuded absorbent is returned to the absorbent treatment. The charging stock from the second absorbent treatment, containing constituents remaining unabsorbed from the first treatment and particularly light unsaturated components, is supplied to the cracking operation. Any of the more easily condensable constituents escaping in the gas and vapor mixture from the first absorbent treatment are also recovered in the second absorbent treatment. Where the absorbed condensable constituents separated in the first absorbent treatment are recovered from the absorbent medium by distillation, any gases and vapors remaining uncondensed in this distillation process, and these may include lighter constituents absorbed in the first absorbent treatment, may with advantage be returned to the second absorbent treatment.

The invention will be further described in connection with the accompanying drawings, which diagrammatically illustrate one form of apparatus adapted for carrying out the process of the invention. Referring to the accompanying drawings, it will be appre-

ciated that different types of apparatus may be employed to carry out the various steps effected in the apparatus shown, that the process is useful in connection with other types of cracking operations, and that a recovery system such as that illustrated may be employed in connection with one or several cracking units.

The cracking still illustrated is of the general type described and illustrated in United States Letters Patent No. 1,285,200, granted November 19, 1918, to the Sinclair Refining Company on the application of Edward W. Isom. The still comprises a bulk supply tank located away from a battery of vertical tubes in a heating furnace, and connections and a circulating pump are provided for circulating oil from the bulk supply tank upwardly through the heating tubes and back to the bulk supply tank. Vapors and gases escape from the bulk supply tank through a reflux tower from which gases and vapors remaining uncondensed escape to a condenser 1. For the production of gasoline or gasoline character distillates from gas oil or gas oil character charging stocks, stills of this type are operated under pressures up to 90 to 125 pounds per square inch or somewhat higher and with lighter charging stocks, such as kerosene character oils, higher pressures up to 300 pounds per square inch or more are used.

From the condenser 1, the condensate and the gases and vapors remaining uncondensed are discharged into a receiver 2 where the condensate and the gas and vapor mixture separate. The pressure on the still system may be regulated and reduced by valves between the still and the condenser or by valves beyond the condenser. Where the condensation is carried out under pressure and the condensate is initially collected under pressure, it is sometimes advantageous to discharge the condensate into another receiver in which the pressure is reduced and from which any liberated gases and vapors are conducted together with the gas and vapor mixture remaining uncondensed under pressure to further treatment. From the receiver 2, the uncondensed gases and vapors escape through connection 3.

This gas and vapor mixture is passed first through scrubbing tower 4 and then through scrubbing tower 5, escaping through connection 6. The connections are arranged for introducing the gas and vapor mixture at the bottom of the scrubbing towers and exhausting it from the upper ends of the scrubbing towers. By-pass connections are also shown for the control and regulation of the scrubbing towers or for emergency use. These scrubbing towers may be of any conventional or desired construction, for example they may be scrubbing towers of conventional construction being fitted interiorly with suit-

able baffles to promote distribution and contacting of the gas and vapor mixtures of the absorbent.

A suitable absorbent, such as mineral seal oil or light straw oil, is circulating in a cycle to the scrubbing tower 4 and the recovery still 7 and back to the scrubbing tower 4 by means of suitable pumps. In the still 7, the absorbent is stripped of constituents absorbed in the scrubbing tower 4, and these constituents are discharged through the condenser 8. The first scrubbing tower and the recovery still through which this absorbent is cyclically circulating may be operated in the customary manner for the recovery of gasoline or similar light oils from gas mixtures containing the same.

In the second scrubbing tower, 5, the gas and vapor mixture escaping from the first scrubbing tower is subjected to treatment with fresh charging stock, for example gas oil, supplied by pump 9 to the upper end of the tower. The absorbent medium together with the constituents absorbed in the tower escape from the bottom of the tower through connection 10 and are then introduced into the cracking still by means of pump 11. This charging stock containing light absorbable constituents may be introduced into the cracking still, for example, directly or after passing through a reflux tower in contact with the vapors and gases escaping from the still, or partly in both ways. A stock tank 12 is shown floating on the charging stock line to the cracking still to permit independent regulation and control of the scrubbing operation and the cracking operation.

Any of the more easily condensable vapors escaping from the first scrubbing tower are recovered in the second scrubbing tower. To avoid overcracking of such constituents, in a system of the type illustrated, all of the charging stock employed in the scrubbing treatment may be introduced into a reflux tower where they are in effect distilled by the heat absorbed from the hot vapors in the refluxing operation so that they escape with the products fresh from the cracking operation to the condenser without being subjected to extreme cracking conditions. Other charging stock, for example stock which has not been employed in such an absorbent treatment, may in this event be supplied to the cracking operation either in admixture with the stock charged with absorbable constituents or directly, for example through connection 13 in the system illustrated.

Likewise, some of the more difficultly condensable constituents may be separated from the gas and vapor mixture in the first scrubbing treatment, so that these constituents again appear as an incondensable gas and vapor mixture on separation of the absorbed

material from the absorbed medium. These constituents, this incondensable gas and vapor mixture, are advantageously returned and introduced into the second scrubbing treatment for the recovery therefrom of the absorbable components. In the apparatus illustrated, a connection 14 is provided for this purpose.

Where the invention is practiced in connection with pressure distillation operations, the part of the still pressure may be employed to force the gas and vapor mixture through the scrubbing towers. The pressure, for example, may be reduced at a point either between the cracking still and the condenser or beyond the condenser to a point sufficiently above atmospheric pressure to effect this end. The circulation of the gas vapor mixture through the scrubbing towers may also be effected by blowers, such as are indicated by the reference character 15, or the gas vapor mixture may be drawn through the scrubbing towers by means of an exhauster indicated at 16.

The invention has several important advantages. In particular, it provides an efficient and economical means of increasing the recovery capacity. It makes it possible to take advantage of the absorbent capacity of the charging stock supplied to the cracking operation without, however, limiting the recovery of valuable condensable constituents in this respect. It also affords an improvement in the return of lighter and more difficultly condensable constituents in that these constituents are displaced from absorbents by heavier hydrocarbons where the absorbent capacity is limited. This same tendency of heavier hydrocarbon constituents to displace lighter hydrocarbon constituents from absorbents also makes the operation of the process of the invention largely self-regulating as it tends to cause the absorption of a predominance of the heavier more easily condensable constituents in the first absorbent treatment while the second absorbent treatment nevertheless acts to prevent the escape of absorbable constituents remaining unabsorbed after the first absorbent treatment. The invention also provides for the recovery of any light and more difficultly condensable constituents separated in the absorbent medium employed in the first absorbent treatment. While the invention is not predicated upon any particular hypothesis, it also seems that the return of the lighter and more reactive constituents, such as are absorbed in the second absorbent treatment, to the cracking operation and par-

ticularly to regions of relatively high temperature in the cracking system may actually afford an increase in the production of the desired lighter condensable hydrocarbons, and the return of such reactive constituents is effected in a particularly advantageous way in carrying out the present invention.

I claim:

1. In cracking operations for the production of lighter hydrocarbon oils from heavier hydrocarbon oils in which vapors and gases are taken off and subjected to a condensing operation, the improvement which comprises subjecting the gas and vapor mixture remaining uncondensed thereafter first to treatment with an absorbent medium from which absorbed constituents are recovered by treatment independent of the cracking operation and then subjecting the still remaining uncondensed and unabsorbed gas and vapor mixture to treatment with charging stock subsequently supplied to the cracking operation.

2. In cracking operations for the production of lighter hydrocarbon oils from heavier hydrocarbon oils in which vapors and gases are taken off and subjected to a condensing operation, the improvement which comprises subjecting the gas and vapor mixture remaining uncondensed thereafter to treatment with an absorbent medium, stripping absorbed constituents from this absorbent by a distillation process, and subjecting the gas and vapor mixture escaping from the first absorbent treatment and the gas and vapor mixture escaping uncondensed from the distillation process to treatment with charging stock subsequently supplied to the cracking operation.

3. In cracking operations for the production of lighter hydrocarbon oils from heavier hydrocarbon oils in which vapors are taken off and subjected to a condensing operation, the improvement which comprises subjecting the gas and vapor mixture remaining uncondensed thereafter first to treatment with an absorbent medium, stripping absorbed constituents from this absorbent medium by a separate distillation process, then subjecting the gas and vapor mixture escaping from the first absorbent treatment to treatment with charging stock, and supplying charging stock containing constituents absorbed in the latter treatment to the cracking operation.

In testimony whereof, I have subscribed my name.

GEORGE H. TABER, Jr.