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ART OF CRACKING HYDROCARBONS

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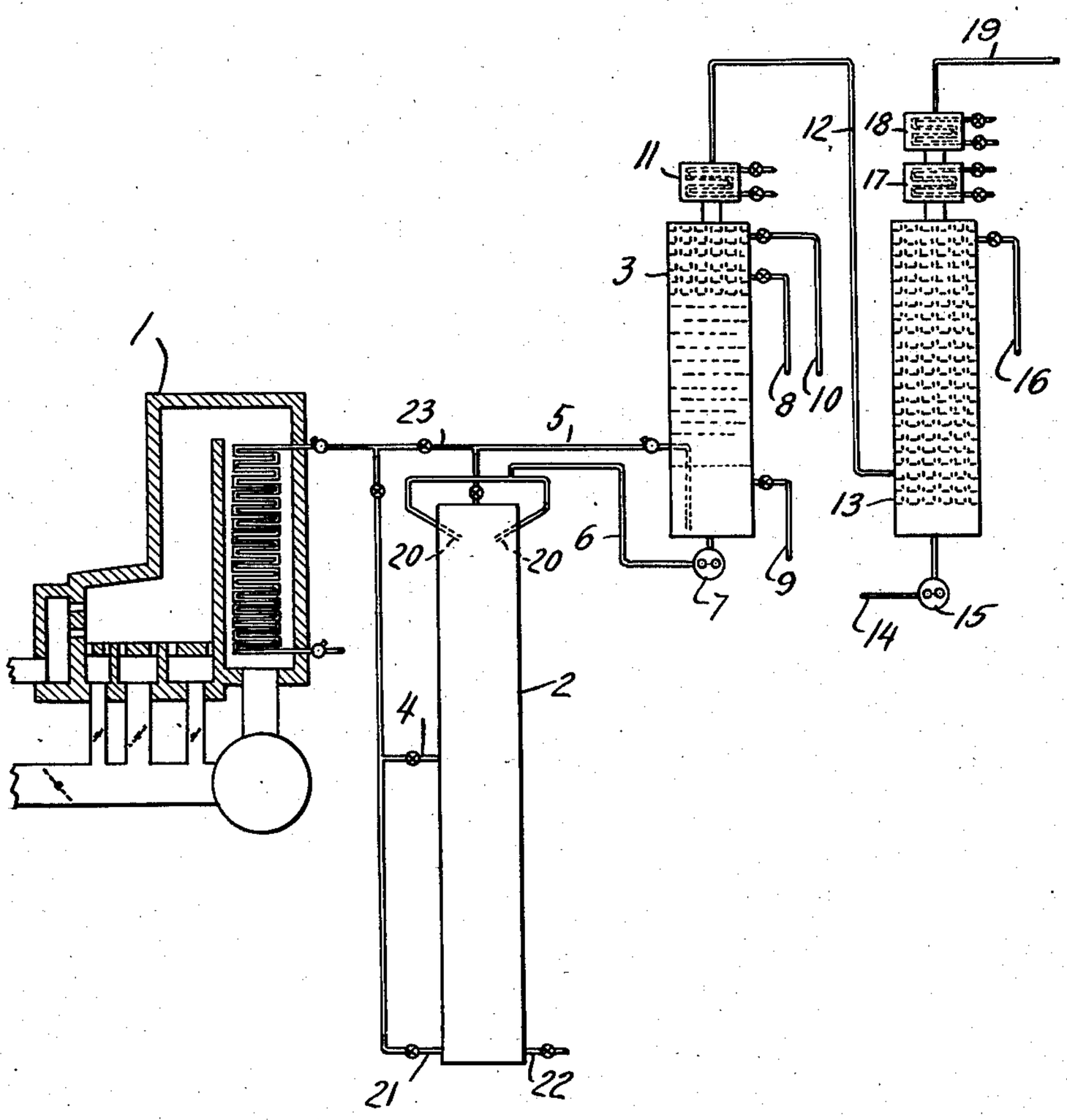

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ART OF CRACKING HYDROCARBONS

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3 Claims. (Cl. 202—15)

This invention relates to improvements in the combined vapor phase cracking of oils, such as gas oil or kerosene stocks, for the production of lower boiling oils, such as gasoline, and the coking of heavy oils, such as crudes, topped crudes, flux oils, other residual oils and the like. This type of combined operation is of special application in the handling of crude stocks or residual stocks the handling of which usually involves difficulties due to corrosion or the products of which are unusually refractory with respect to the usual refining operations, because of the character or quantity of sulphur compounds in the stock, for example, but this type of combined operation, in certain aspects, is of more general application. This invention relates more particularly to improvements in the coking operation proper in this type of combined operation. In one aspect, this invention relates to improvements in the type of combined operation described in application Serial No. 347,533, filed March 16, 1929, by us; issued as Patent No. 1,873,068.

The improved coking operation of this invention is of special value in the combined operation described in application Serial No. 340,996, filed February 18, 1929, by Harry L. Pelzer, issued as Patent No. 1,831,719, but it is also of more general application in this type of combined operation.

As usually practiced, this type of combined operation involves passage of the hot vapor mixture from the vapor phase cracking operation not only through the oil stock or mixture to be reduced to coke but also through the accumulating charge of coke throughout the coking operation. As a consequence, the coke so produced is usually of lower density than the coke produced from similar stocks in the conventional coke still; 30–50 pounds per cubic foot as compared to 40–60 pounds per cubic foot for example. This invention provides improvements in the coking operation proper which, in this type of combined operation, make it possible materially to increase the density of the coke produced.

According to this invention, the hot vapor mixture from the vapor phase cracking operation, while still at high temperature, is introduced into an externally unheated vertically elongated coking receptacle from which vapors are taken off from the upper end at a fixed intermediate point and a liquid oil stock or mixture to be reduced to coke is sprayed into this coking receptacle above the point of introduction of the hot vapor mixture from the vapor phase cracking operation, the initial coke product produced in the upper part of the coking receptacle by the intimate contact in countercurrent flow between the hot vapor mixture and the liquid oil stock therein accumulates in the lower part of the coking receptacle below the point of introduction of the hot vapor mixture from the vapor phase cracking operation and is there reduced to the final coke product, dried, by the introduction of a suitable drying medium such as superheated steam or superheated hydrocarbon gases or vapors into the coking receptacle near its lower end, and the final coke product is discharged as such from the lower part of the coking receptacle. The initial coking is thus effected by a particularly effective heat exchange while the final coking is thus effected in a manner promoting the production of a dense final coke product. This coking operation is, moreover, simple and easily controlled.

The drying of the coke product in the lower part of the coking receptacle may be effected by the introduction of superheated steam or superheated hydrocarbon gases or vapors, for example, near the lower end of the coking receptacle, but it is advantageously effected by the introduction, at this point, of a minor part of the hot vapor mixture from the vapor phase cracking operation, the major part of the hot vapor mixture from the vapor phase cracking operation being introduced as above described. Whatever drying medium is used, the density of the coke product is improved by limiting the proportion of the drying medium introduced to the minimum necessary to effect the desired reduction.

The initial coking carried out in the upper part of the coking receptacle tends to involve entrainment of liquid or semi-liquid particles in the vapors taken off from the upper end of the coking receptacle and, for this reason, these vapors are advantageously subjected to a scrubbing operation from which liquid material separated in the scrubbing operation is returned to the coking receptacle with the liquid oil stock or mixture to be reduced to coke therein. The scrubbing operation may be carried out, for example, as described in Patent No. 1,831,719, mentioned above.

The invention will be further described in connection with the accompanying drawing which illustrates, diagrammatically and conventionally, one form of apparatus adapted for carrying out the invention, but it is intended and will be understood that the invention can be carried

out in other and different forms of apparatus.

In carrying out the invention in the apparatus illustrated, an oil such as a gas oil stock or a kerosene stock is supplied to the heater 1 and heated to a high cracking temperature, upwards of 950–1050° F., in the vapor phase therein, the resulting hot vapor mixture while still at a high temperature, upwards of 950–1050° F. is introduced into the coking receptacle 2, vapors are taken off from the coking receptacle 2 and introduced into the scrubbing tower 3, an oil to be reduced to coke is supplied to the scrubbing tower 3, the liquid oil mixture formed in the scrubbing tower 3 is supplied to the coking receptacle 2, a coke product is periodically discharged from the coking receptacle 2, and vapors are taken off from the scrubbing tower 3 and subjected to suitable condensing or fractionating and condensing or other recovery operations which may include the separation of stocks to be supplied to the heater 1. In general, the operation may be carried out generally as described in Patent No. 1,831,719 mentioned above.

The vapor phase cracking operation proper may be carried out, for example, as described in application Serial No. 198,621 filed June 13, 1927, by Harry L. Pelzer, and the hot vapor mixture from the digesting drums introduced into the coking receptacle 2, or the digesting drums may be omitted and the hot vapor mixture from the heater proper introduced into the coking receptacle 2. Reference is made to this particular vapor phase cracking operation, however, solely for the purpose of illustration; the apparatus or the precise manner in which the vapor phase cracking operation is carried out is not important so long as the hot products of the operation are available to be introduced into the coking receptacle 2 through connection 4 at temperatures upwards of 950–1050° F.

In the scrubbing tower 3, the vapors taken off from the coking receptacle 2 through connection 5 are introduced into and beneath the surface of the liquid body of oil maintained therein and from which the liquid oil stock or mixture to be reduced to coke is supplied to the coking receptacle 2 through connection 6 by means of pump 7. The oil to be reduced to coke may be supplied to the scrubbing tower 3 through either or both of connections 8 and 9. A refluxing medium, gas oil for example, may be supplied to the scrubbing tower 3 through connection 10. Reflux condensate may also be supplied as a refluxing medium to the scrubbing tower 3 from reflux condenser 11 by circulating a cooling medium therethrough. The operation of the scrubbing tower 3 may be regulated to maintain the liquid oil body into which the vapors from the coking receptacle 2 are discharged at a temperature in the neighborhood of 700–825° F., the oil stock or oil mixture to be reduced to coke thus being supplied to the coking receptacle 2 through connection 6 preheated to this temperature. The scrubbing tower 3 may be arranged and operated, for example, as described in application Serial No. 345,199, filed March 7, 1929, by Eugene C. Herthel; issued as Patent No. 1,810,048.

The vapors escaping from the scrubbing tower 3 through connection 12 are discharged into fractionating tower 13 in which, for example, higher boiling components suitable to be supplied to the vapor phase cracking operation carried out in heater 1 are condensed, the condensate being discharged through connection 14 by means of pump 15. This condensate may include high boiling components of oil stocks introduced into the scrubbing tower and vaporized therein as well as high boiling components discharged from the vapor phase cracking operation or the coking operation. The operation of the fractionating tower 13 may be regulated by the introduction of a refluxing medium through connection 16 or by means of the reflux condensers 17 and 18 or either of them or by both of these means. Vapors including the vapors of the low boiling oil product escape from the fractionating tower 13 through connection 19 to a condenser or to other fractionating and treating or other recovery apparatus, not shown.

The coking operation of this invention is carried out in the receptacle 2. In the apparatus illustrated, this coking receptacle is an externally unheated, but thermally insulated, vertically elongated drum provided with a connection 4 for introducing the hot vapor mixture from the vapor phase cracking operation at a fixed intermediate point, with a connection 5 for taking off vapors from the upper end of the drum, with nozzles 20 with which connection 6 communicates for spraying a liquid oil stock to be reduced to coke into the drum above the point at which the hot vapor mixture from the vapor phase cracking operation is introduced through connection 4, with connection 21 for the introduction of a minor part of the hot vapor mixture from the vapor phase cracking operation into the lower end of the drum as a drying medium and with connection 22 for the introduction of any other drying medium into the lower end of the drum. This drum, for example, may be 7–9 feet in diameter and 30–40 feet high. In carrying out the invention in the coking receptacle illustrated, for example, the hot vapor mixture from the vapor phase cracking operation is introduced into the coking receptacle 2 through connection 4 at a temperature of 1100–1150° F., for example, and discharged from the upper end of the coking receptacle through connection 5 after passing through the upper part of the coking receptacle and the liquid oil stock or mixture to be reduced to coke is sprayed into the upper part of the coking receptacle 2 and into the vapor mixture passing therethrough through the nozzles 20 at a temperature of 775–825° F., for example. The vaporizable components of the stock sprayed through nozzles 20 are rapidly and nearly completely separated in the upper part of the coking receptacle 2 to escape through connection 5 with the vapors from the vapor phase cracking operation by direct heat exchange in countercurrent flow between the stock sprayed into the coking receptacle and the hot vapor mixture from the vapor phase cracking operation. The initial coke product, the product of this heat exchange, falls through the coking receptacle 2 into the lower part of the coking receptacle below the point at which the hot vapor mixture from the vapor phase cracking operation is introduced through connection 4 and, accumulating in this lower part of the coking receptacle, is there reduced to a relatively dense final coke product by the introduction of a limited proportion of a drying medium near the lower end of the coking receptacle through connection 21 or 22 or through both of these connections. This drying medium may consist, for example, of 5–15% of the hot vapor mixture from the vapor phase cracking operation, or it

may consist of super-heated steam at a corresponding temperature or other superheated hydrocarbon gases or vapors at a corresponding temperature and in similarly limited proportion. When the coke charge accumulating in the coking receptacle 2 approximates in level the point at which the hot vapor mixture of the vapor phase cracking operation is discharged into the coking receptacle through connection 4, the coking operation is interrupted and the charge of coke is discharged through the lower end of the coking receptacle. During such periods of interruption of the coking operation, the coking receptacle 2 may be by-passed by means of connection 23 and the hot vapor mixture from the vapor phase cracking operation discharged directly into the scrubbing tower, or the coking receptacle illustrated may be but one of a series to permit the coking operation to be carried out in successive coking receptacles.

The discharge of the final coke product from the coking receptacle may be effected, for example, as described in application Serial No. 344,952 filed March 7, 1929, by Oliver F. Campbell and Eugene C. Herthel issued as Patent No. 1,872,884 or as described in application Serial No. 345,016 filed March 7, 1929, by Willis S. Gullette, issued as Patent No. 1,872,938.

We claim:

1. In a combined vapor phase cracking and coking operation, the improvement which comprises introducing the hot vapor mixture from the vapor phase cracking operation into an externally unheated vertically elongated coking receptacle at a fixed intermediate point between the upper and lower portions of said coking receptacle, taking off vapors from the upper end of said coking receptacle and spraying a liquid oil stock to be reduced to coke into said coking receptacle above the point of introduction of the hot vapor mixture from the vapor phase cracking operation whereby this stock and the hot vapor mixture are brought into intimate contact in countercurrent flow in the upper part of said coking receptacle and thereby producing coke and accumulating said coke in the lower part of said coking receptacle below the point of introduction of the hot vapor mixture from the vapor phase cracking operation, introducing a hot gaseous drying medium into said coking receptacle near its lower end and thereby drying the coke in the lower part of said coking receptacle, and discharging the final coke product therefrom.

2. In a combined vapor phase cracking and coking operation, the improvement which comprises introducing the major part of the hot vapor mixture from the vapor phase cracking operation into an externally unheated vertically elongated coking receptacle at a fixed intermediate point between the upper and lower portions of said coking receptacle, taking off vapors from the upper end of said coking receptacle and spraying a liquid oil stock to be reduced to coke into said coking receptacle above the point of introduction of the hot vapor mixture from the vapor phase cracking operation whereby this stock and the hot vapor mixture are brought into intimate contact in countercurrent flow in the upper part of said coking receptacle and thereby producing coke and accumulating said coke in the lower part of said coking receptacle below the point of introduction of the hot vapor mixture from the vapor phase cracking operation, introducing a minor part of the hot vapor mixture from the vapor phase cracking operation into said coking receptacle near its lower end to dry the coke accumulating in the lower part of said coking receptacle, and discharging the final coke product therefrom.

3. In a combined vapor phase cracking and coking operation, the improvement which comprises introducing the hot vapor mixture from the vapor phase cracking operation into an externally unheated vertically elongated coking receptacle at a fixed intermediate point between the upper and lower portions of said coking receptacle, taking off vapors from the upper end of said coking receptacle and spraying a liquid oil stock to be reduced to coke into said coking receptacle above the point of introduction of the hot vapor mixture from the vapor phase cracking operation whereby this stock and the hot vapor mixture are brought in intimate contact in countercurrent flow in the upper part of said coking receptacle and thereby producing coke and accumulating said coke in the lower part of said coking receptacle below the point of introduction of the hot vapor mixture from the vapor phase cracking operation, subjecting the vapors taken off from the upper end of said coking receptacle to a scrubbing operation and returning liquid material separated in the scrubbing operation to said coking receptacle with the liquid oil stock to be reduced to coke, introducing a hot gaseous drying medium into said coking receptacle near its lower end and thereby drying the coke in the lower part of said coking receptacle, and discharging the final coke product therefrom.

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