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CRACKING PROCESS

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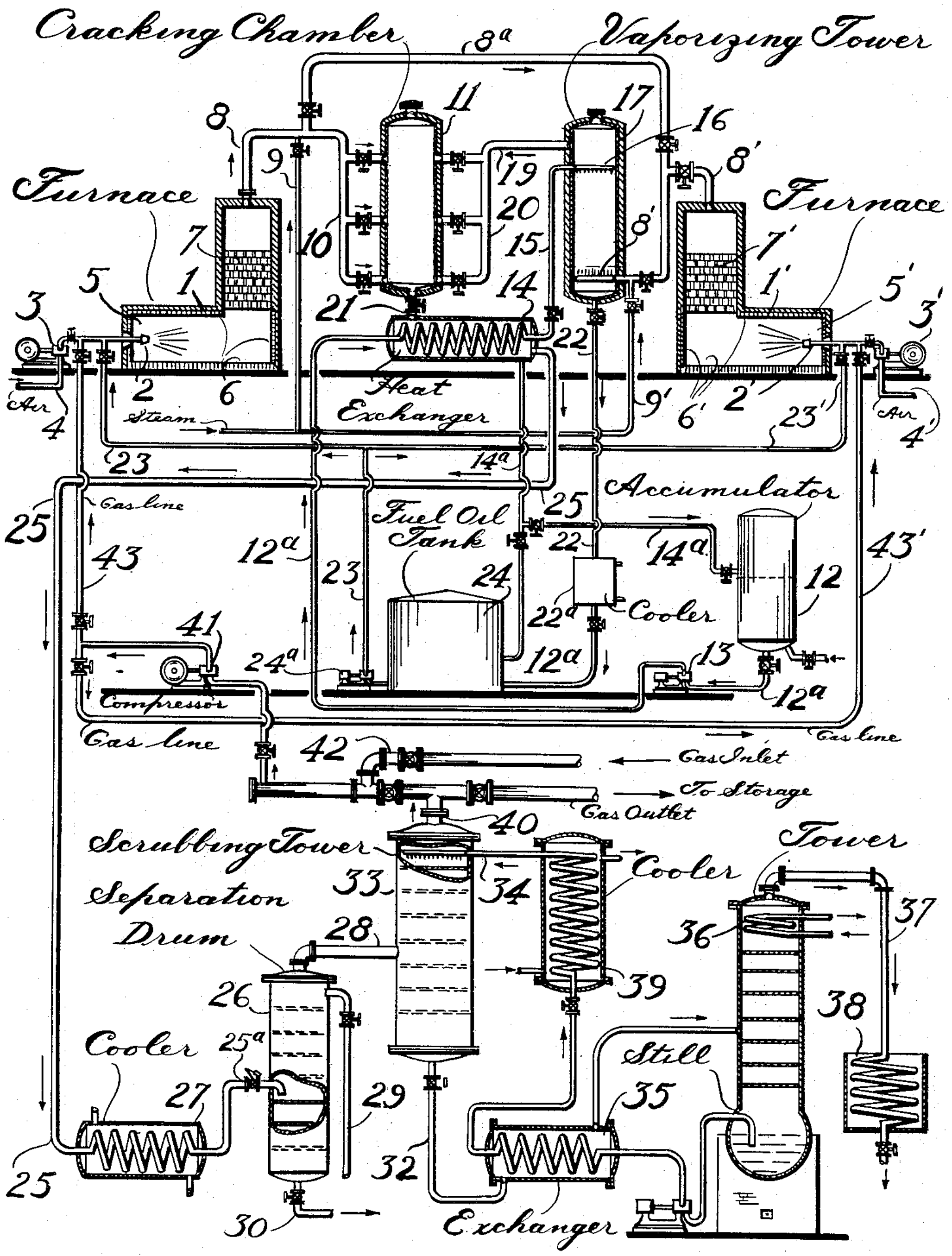

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CRACKING PROCESS

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4 Claims. (Cl. 196—67)

This invention relates to the art of decomposition or cracking of mineral oils by direct contact with heated gases and it is a continuation in part of my prior application Serial No. 310,255. The specific purpose of the present application is to improve the process of the application Serial No. 310,255 so as to make it available for the treatment of very low grade cracking stocks, such as topped asphalt base crudes, low grade fuel oils, etc.

Briefly, the process consists of vaporizing the heavy oil to be cracked, in contact with hot, non-oxidizing gases, drawing off the unvaporized heavy portion, introducing the gas and vapor mixture into a cracking chamber where they come in contact with a further quantity of very hot, non-oxidizing gases. Preferably higher than atmospheric pressure is maintained in the apparatus during these operations. The heavier hydrocarbons decompose into light hydrocarbons and are drawn off, cooled and separated from the uncondensible gases.

The drawing is a semi-diagrammatic vertical section of an apparatus for accomplishing this improved process and clearly indicates the flow of materials.

Referring to the drawing, reference character 1 designates a furnace or combustion chamber heated with a burner 2 which may be fed either by line 43 with gaseous fuel or by line 23 with fuel oil. Since the process is operated under higher than atmospheric pressure, the air is supplied to the burner by compressor 3 and line 4. The combustion chamber 5 is lined with fire brick 6 and may be filled with checker brick as shown at 7 to effect the combustion in a short time and in a comparatively small space. The furnace 1 may be replaced by any other source of hot, non-oxidizing gases such as a gas producer the products of which consist mainly of nitrogen, carbon monoxide, carbon dioxide and water vapor. The source of hot non-oxidizing gases will be termed gas generating zone in the claims.

The combustion gases leave furnace 1 by the flue 8 and after admixture with the proper amount of steam supplied by line 9, are discharged through the manifold 10 into the well insulated cracking chamber 11. It is also feasible to entirely eliminate the furnace (1) or the gas producer and use highly super-heated steam alone for admixture with the oil vapors to be cracked.

The cracking stock is passed from the accumulator 12 through line 12*a*, pump 13, heat exchanger 14, line 15 and is discharged through the spray 16 into the vaporizing tower 17. There are also discharged into the vaporizing tower hot, non-oxidizing gases through line 8′. These gases may be bypassed from line 8 through line 8*a* or may be obtained from a separate source such as the furnace 1′. The numerals 1′—8′, 23′ 43′ designate elements analogous to 1—8, 23 and 43 respectively. Line 19 and manifold 20 connect the vaporizing tower 17 with the cracking chamber 11 for the introduction into the latter of the mixture of oil vapors and non-oxidizing gases from the tower. The unvaporized oil residue leaves the tower 17 through line 22 and is passed through a cooler 22*a* to the fuel oil tank 24 from which it may be conveyed to the burners 2 and 2′ through lines 23 and 23′. A pump 24*a* is inserted in line 23 to supply the fuel oil to the furnace under sufficient pressure.

The cracked vapors and gases leave the cracking chamber 11 through line 21, preferably located at or near the bottom of the chamber, and are passed through heat exchanger 14 and line 25 into the separation drum 26. The heavy fraction condensed in the exchanger 14 is conveyed through line 14*a* either to the accumulator 12 or to the fuel oil tank 24. A cooler 27 may be inserted in the line 25 to effect the desired condensation of the products passing into drum 26. Line 25 is preferably provided with a pressure release valve 25*a*. In the drum, gas, oil and water are withdrawn respectively by lines 28, 29 and 30. Water is carried to the sewer, the oil to storage (not shown) and the gas to a system for the recovery of normally liquid hydrocarbons.

The recovery system may be of any approved type. In the drawing, an absorption type is shown for the purpose of illustration. The gas and uncondensed vapors are conducted to the base of scrubbing tower 33. Absorption liquid such as straw oil is introduced at the top by line 34 and while flowing countercurrent to the gases absorbs the vapors of the normally liquid hydrocarbons from the latter. The oil is withdrawn, preheated in exchanger 35 and fed into a suitable tower stripping still 36. The distillate is removed by vapor line 37 to condenser 38 and storage (not shown) and the liquid after passing through exchanger 35, and a cooler 39, is returned to tower 33 by pipe 34. The stripped gas leaves through line 40. A part of the gas may be compressed by compressor 41 and after admixture with fresh hydrocarbon gas from line

42 may be returned to the burners 2 and 2' by lines 43 and 43' respectively.

In the operation of my process a fuel such as natural gas, refinery gas, fuel oil, etc. is burned preferably under a gauge pressure of 5 to 50 lbs. per square inch, although pressure may be considerably higher. The fuel is burned with as little excess air as conveniently possible whereby combustion temperatures in the neighborhood of 2500–3000° F. are obtained. The highly heated gas is then admixed with a large amount of steam under pressure and at a much lower temperature so as to reduce the gas temperature to approximately 1400–1600° F., say 1500° F. in the manifold 10 and to 1000–1200° F. at the outlet end of line 8'. When the line 8' is supplied by the bypass line 8*a* additional steam is supplied from line 9'. The cracking stock such as a topped asphalt base crude, low grade fuel oil, etc. is pumped from the accumulator through the heat exchanger 14 into the vaporizing tower 17 into which it is discharged through spray head 16. The liquid hydrocarbons come into intimate contact with the hot-non-oxidizing gases and vaporize to a great extent. The temperature in the vaporizing zone is at approximately 750–850° F. The unvaporized asphaltic residue is passed through line 22 and cooler 22*a* to the fuel oil tank 24. A certain amount of cracking may also take place in the vaporizing tower 16, however, the bulk of the hydrocarbon vapor remains uncracked, leaves the tower 16, in admixture with the gases, through line 19 and is then introduced into the cracking chamber by manifold 20. In cracking chamber 11 the hydrocarbon vapors become thoroughly admixed with the hot non-oxidizing gases which enter by the manifold 10. The temperature in the cracking chamber is high, about 900–1400° F. and consequently the hydrocarbon vapors undergo a very thorough cracking.

Pressure may be maintained on the furnaces, vaporizing tower and cracking chamber of for example a gauge pressure from 5–50 lbs. per square inch. If desired, the apparatus can be operated at atmospheric pressure and some of the advantages of the invention will be retained. The gases and cracked vapors leaving together through line 21 are cooled in the heat exchanger 14 and finally condensed in cooler 27, after which the various products gas, oil, water are separated as it is easily understood from the drawing and the description of the apparatus. The heavy product condensed in heat exchanger 14 may be returned to the cracking process. The residual gases are treated for the removal of light oils and the oily products from drum 26 may be distilled to separate the low boiling from the high boiling fractions. The latter may be returned to the cracking process.

The operating pressure is either released at the valve 25*a*, or the separation drum and the gas absorber may also be held under pressure.

The following example will illustrate the operation and the yields obtained.

A residual fuel oil obtained as tar in a liquid phase cracking process and having a gravity of 8° A. P. I. was submitted to cracking by the present process under a gauge pressure of 5 lbs./sq. in. The temperatures were 850° F. in the vaporizing tower and 1200° F. in the cracking chamber. There were obtained:

15% non-condensed gas
74.8% oil (synthetic crude)
10% heavy fraction from the heat exchanger 14

The synthetic crude gave on fractionation:

25% gasoline with 400° F. end point of distillation.
50% gas oil
25% residual fuel bottoms

I claim:

1. An improved process for cracking hydrocarbon oil by direct contact with hot gases which comprises generating a hot non-oxidizing gas at a high temperature in a gas generating zone, cooling the gas to an appropriate temperature by admixing steam therewith to obtain a hot non-oxidizing gas-steam mixture, introducing the hydrocarbon oil together with part of the hot non-oxidizing gas-steam mixture into a separate vaporizing zone to effect the vaporization of a substantial part of the oil, separately removing the unvaporized oil and the mixture of vaporized oil and non-oxidizing gas, passing the last mentioned mixture into a separate cracking zone, introducing the rest of said hot non-oxidizing gas-steam mixture into the cracking zone at a temperature sufficient to effect a substantial cracking of the vaporized hydrocarbon oil, maintaining a substantially uniform temperature throughout the cracking zone, removing the cracked products from the cracking zone and separating low boiling oil from said removed cracked products.

2. The process according to claim 1 in which the cracking zone is maintained under a gas pressure of from 5–50 pounds per square inch.

3. The process according to claim 1 in which a temperature of from 750–850° F. is maintained in the vaporizing zone.

4. The process according to claim 1 in which the mixture of vaporized oil and non-oxidizing gas is passed into the cracking zone at a plurality of widely spaced points.

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