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COKING HYDROCARBON OILS

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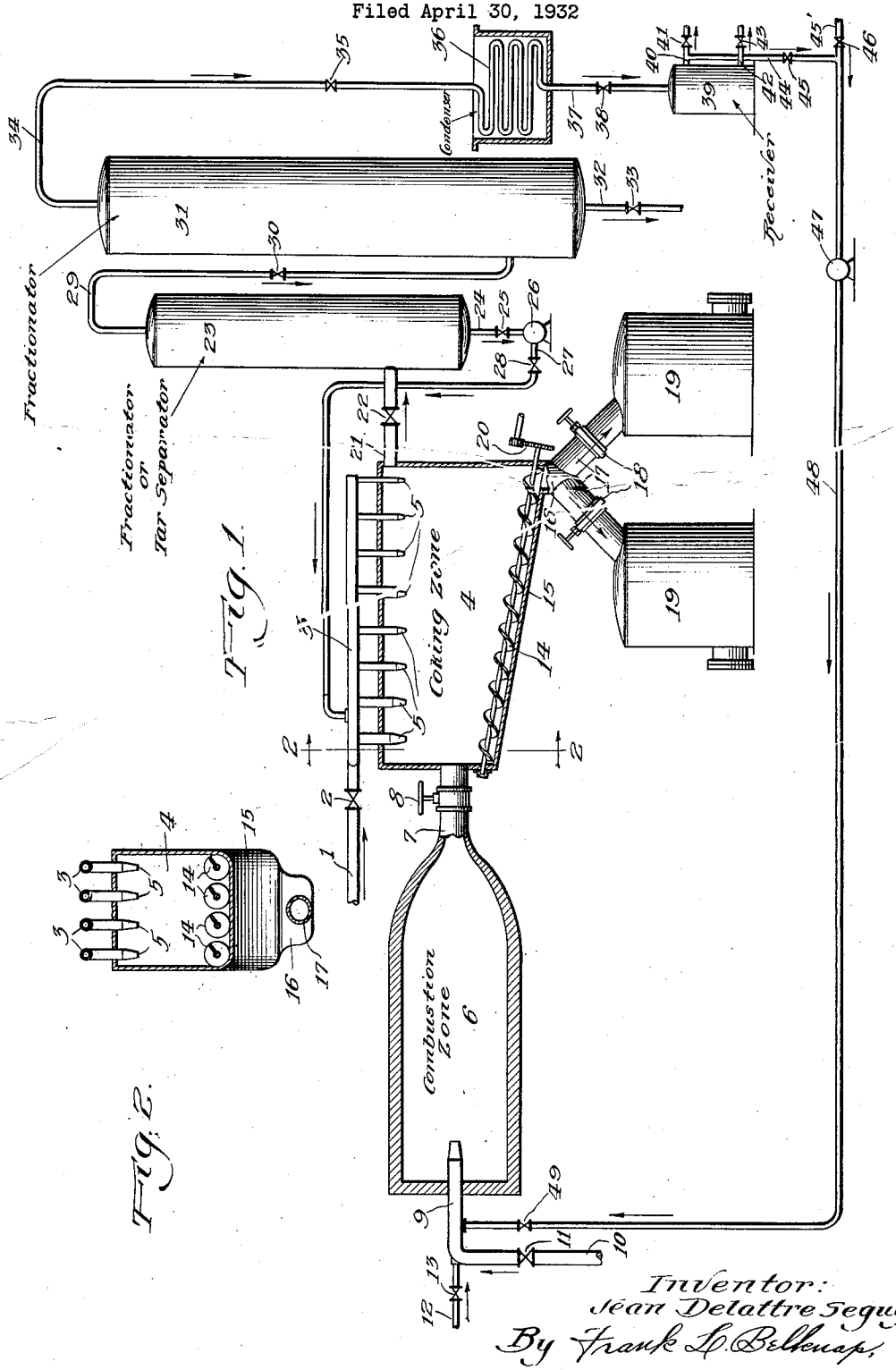


Fig. 1.

Fig. 2.

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COKING HYDROCARBON OILS

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4 Claims. (Cl. 196—67)

This invention relates to the coking of hydrocarbon oils and more particularly refers to an improved process and apparatus for the continuous coking of hydrocarbon oils by direct contact with hot combustion gases.

In its primary concepts the invention comprises an improved process and apparatus for the coking of relatively heavy hydrocarbon oils wherein the oil is introduced into a low pressure coking zone in a plurality of streams, preferably of progressively smaller size, hot combustion gases are simultaneously introduced into direct contact with said streams, thereby effecting reduction of the oil to coke, the coke produced is continuously removed from the coking zone, vaporous products are separately withdrawn from the coking zone and are subjected to fractionation and scrubbing for the separation of desirable liquefiable components from heavy tars and gases, said heavy tars are returned to the coking zone for further treatment and uncondensable gas from the system is supplied as fuel to the combustion zone of the process.

The features of the invention will be found advantageous in the coking of any type of oil and are especially well adapted to the treatment of relatively heavy oils supplied to the process in either cold or heated state, and particularly residual oil resulting from cracking which may be withdrawn hot from the cracking process and supplied to the coking zone of the present process without substantial loss of heat.

The attached diagrammatic drawing, Figs. 1 and 2, illustrates one specific form of apparatus incorporating the features of the present invention.

Fig. 1 is a side elevational view of the apparatus partially in cross section, and Fig. 2 is a section through the coking zone taken along line 2—2 in Fig. 1.

The advantages and features of the invention will be better understood by reference to the drawing and the following description thereof. The description of the drawing includes a description of the operation of the process, as it may be practiced in the apparatus shown. The oil to be treated which, as already stated, may be either in a cold or heated state, is supplied through line 1 and valve 2 to manifold 3 wherefrom it is introduced into coking zone 4 through a plurality of jets or nozzles 5. The jets or nozzles 5 are preferably of progressively smaller size from the inlet to the outlet end of the coking zone, i. e. as from left to right in the drawing, so that more oil is supplied to the hot end of the combustion zone into which the hot combustion gases are introduced than at the cooler end of the combustion zone from which vaporous products are withdrawn and progressively less fresh oil to be coked is contacted with the hot combustion gases as cooling of the gas progresses during their travel from the inlet to the outlet of the coking zone.

Simultaneously with the introduction of the oil to be coked into the coking zone, hot combustion gases, generated in a suitable combustion zone 6, are introduced into one end of the coking zone through duct 7, controlled by valve or damper 8. A suitable burner 9 supplies air or other combustion supporting gas, introduced through line 10 and valve 11, and combustible fuel of any suitable form, introduced through line 12 and valve 13, to the combustion zone wherein the hot combustion gases are generated, preferably at atmospheric or superatmospheric pressure. Combustion may be so controlled in combustion zone 6 that there is substantially no excess air in the hot combustion products leaving this zone so that coking of the oil is accomplished entirely by the heat contained within the combustion gases or, when desired, any suitable quantity of excess air may be introduced into the combustion zone and supplied with the combustion products into coking zone 4 where it will support partial combustion of the material undergoing coking to increase the temperature in this zone and assist coking and devolatilization.

Coking zone 4 is preferably maintained at substantially atmospheric or subatmospheric pressure and, although not illustrated in the drawing, both combustion zone 6 and coking chamber 4 may be and preferably are, heavily insulated to prevent the excessive loss of heat by radiation.

Any suitable means of continuously or intermittently removing the petroleum coke from the coking zone may be provided and in the particular apparatus illustrated in the drawing, a plurality of helical conveyors 14, driven by any suitable means not shown, through gears 20, are located along the bottom of the coking zone by means of which the coke is moved along the inclined bottom 15 of the coking zone to the outlet 16 wherefrom it is discharged through branches 17 controlled by valve 18 into a plurality of carbon-collecting drums 19. A plurality of carbon-collecting drums 19 are preferably employed so that while one is being filled with coke, another previously filled drum may be cleaned and prepared for further operation, thus permitting prolonged continuous operation of the process.

Combustion gases and vaporous hydrocarbons, resulting from coking of the oil, are removed from the coking zone through line 21, valve 22 and are introduced into fractionator or tar separator 23 wherein the heaviest components of the vapors, comprising tars and other materials of high coke-forming characteristics are separated from the lighter vapors and gases. The heavy high coke-forming oils are withdrawn from fractionator 23 through line 24 and valve 25 to pump 26 by means of which they are returned through line 27 and valve 28 to the manifolds 3, preferably at a point between two of the larger of the nozzles 5, through which the oil from zone 23 is introduced into the coking zone, together with charging stock from line 1, and there subjected to further coking.

Vapors escaping condensation in column 23 are withdrawn through line 29 and valve 30 to further fractionation in fractionator 31 by means of which additional liquid components of the vapors of lower boiling characteristics than the heavy tars separated in fractionator 23 and of higher boiling characteristics than the desirable light liquid product of the system are condensed as reflux condensate which collects in the lower portion of fractionator 31 and may be withdrawn through line 32 and valve 33 to cooling and storage or to any desired further treatment, and may, when desired, be recycled to further conversion in the same cracking system from which the residual oil to be coked is obtained, when the oil to be coked is obtained from such a source.

Vapors and gases remaining uncondensed in fractionator 31 are withdrawn through line 34 and valve 35 to condensation and cooling in condenser 36 wherefrom the condensed and uncondensed materials pass through line 37 and valve 38 to be collected in receiver 39. Uncondensed products, including combustion gases, hydrocarbon gases and entrained liquefiable hydrocarbons may be released from receiver 39 through line 40 and valve 41 and are preferably subjected to absorption or scrubbing, by well known means not shown in the drawing, for the removal of the desirable light liquefiable hydrocarbons which may be blended back with the distillate withdrawn from receiver 39 through line 42 and valve 43, this blended product forming the desirable light liquid product of the system which preferably comprises materials boiling within the range of motor fuel and of high anti-knock value. A portion of the gas withdrawn from receiver 39 or preferably a portion of the lean gas from the process, i. e. gas from receiver 39 after scrubbing or absorption, for the removal of liquefiable components, may be returned to combustion zone 6 to serve as a portion or all of the fuel required by the process. Line 44, controlled by valve 45, serves as a means of removing gas for this purpose from receiver 39 and line 45', controlled by valve 46, serves as a means of returning the lean gas. Either of these gases thus supplied to pump or compressor 47 are returned through line 48 and valve 49 to burner 9 and thence to combustion zone 6.

Pump 47 may serve as a vacuum pump for maintaining sub-atmospheric pressure in the coking zone and succeeding portions of the system or, when desired, a vacuum pump may be interposed, for example, in line 21 or in line 29 for the purpose of maintaining subatmospheric pressure in the coking zone alone or in the coking zone and any desired portion of the succeeding equipment, although such means are not illustrated in the drawing.

As already mentioned, the combustion zone may be operated at substantially atmospheric or low superatmospheric pressure up to 60 pounds, or thereabouts, per square inch. The coking zone may be operated at substantially atmospheric or subatmospheric pressure. Temperatures employed in the coking zone may range from 1200 to 1600° F., or thereabouts. The portions of the system succeeding the coking zone may be operated at substantially equalized or increased pressure relative to that employed in the coking zone.

As a specific example of the operation of the process of the present invention, heavy residual oil resulting from cracking is introduced into the coking zone through a plurality of streams of progressively decreasing size at a temperature of approximately 780° F. Hot combustion gases generated under a superatmospheric pressure of about 10 pounds per square inch are passed through the coking zone and directly contacted with the streams of residual oil. The minimum temperature in the coking zone is about 1000° F. Vaporous products from the coking zone are subjected to fractionation and scrubbing for the recovery of condensable components and the heavy tars separated by primary fractionation of the vapors are returned to the coking zone. Coke is continuously withdrawn from the coking zone and a portion of the lean gas from the system is returned to the combustion zone as fuel. This operation may yield, per barrel of charging stock, about 140 pounds of coke of low volatility, about 8 gallons of distillate boiling within the range of motor fuel and having an octane number of approximately 82. The other products of the system comprise about 7½ gallons of intermediate liquid products suitable for use as cracking stock and about 3500 cubic feet of gas, per barrel of charging stock. The gas is a mixture of hydrocarbon gases and combustion gases and may have a calorific value of about 500 B. t. u.'s

I claim as my invention:

1. In a process for the continuous coking of hydrocarbon oil wherein the oil is introduced into a coking zone and there directly contacted with hot combustion gases whereby said oil is reduced to coke, the improvement which comprises introducing the oil into the coking zone in a plurality of streams of graduated and progressively smaller cross-section, and passing the combustion gases through the coking zone in the direction of decreasing cross-section of said streams.

2. A process such as is claimed in claim 1 wherein subatmospheric pressure is employed in the coking zone.

3. A process for the coking of hydrocarbon oils which comprises introducing the oil into a coking zone in a plurality of streams of graduated and progressively smaller cross-section, generating combustion gases in a combustion zone and passing the hot combustion products through the coking zone in the direction of decreasing cross-section of said streams, whereby the oil is reduced to coke, removing coke from the coking zone, removing vaporous and gaseous hydrocarbons together with combustion gases from the coking zone, separating from the mixture of vapors and gases heavy tars and similar coke-forming materials, returning the latter to the coking zone, then cooling the mixture of vapors and gases to condense vaporous hydrocarbons con-

tained therein and returning at least a portion of the latter gaseous hydrocarbons to the combustion zone to serve as fuel for the process.

4. In the coking of hydrocarbon oil in a coking zone wherein progressively decreasing temperatures prevail from one end of the coking zone to the other end thereof, the improvement which comprises introducing the oil to the coking zone in a plurality of streams at longitudinally spaced points between said ends of the coking zone, said streams being of progressively smaller cross-section in the direction of decreasing temperatures through the coking zone.

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