April 2, 1935. J. B. HEID 1,996,243

PROCESS OF HYDROCARBON OIL CONVERSION

Filed Nov. 19, 1930 2 Sheets-Sheet 1

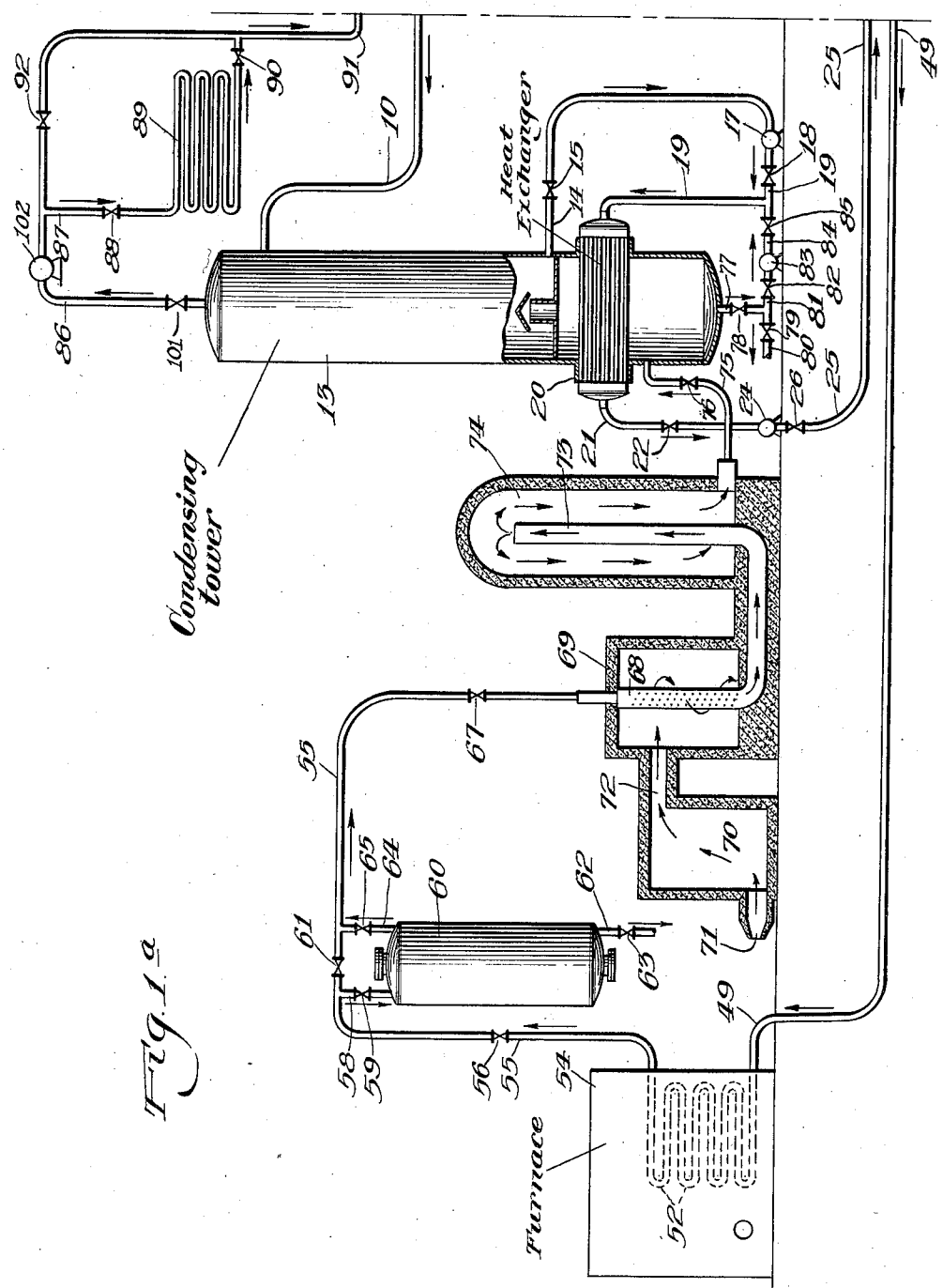


Fig. 1a

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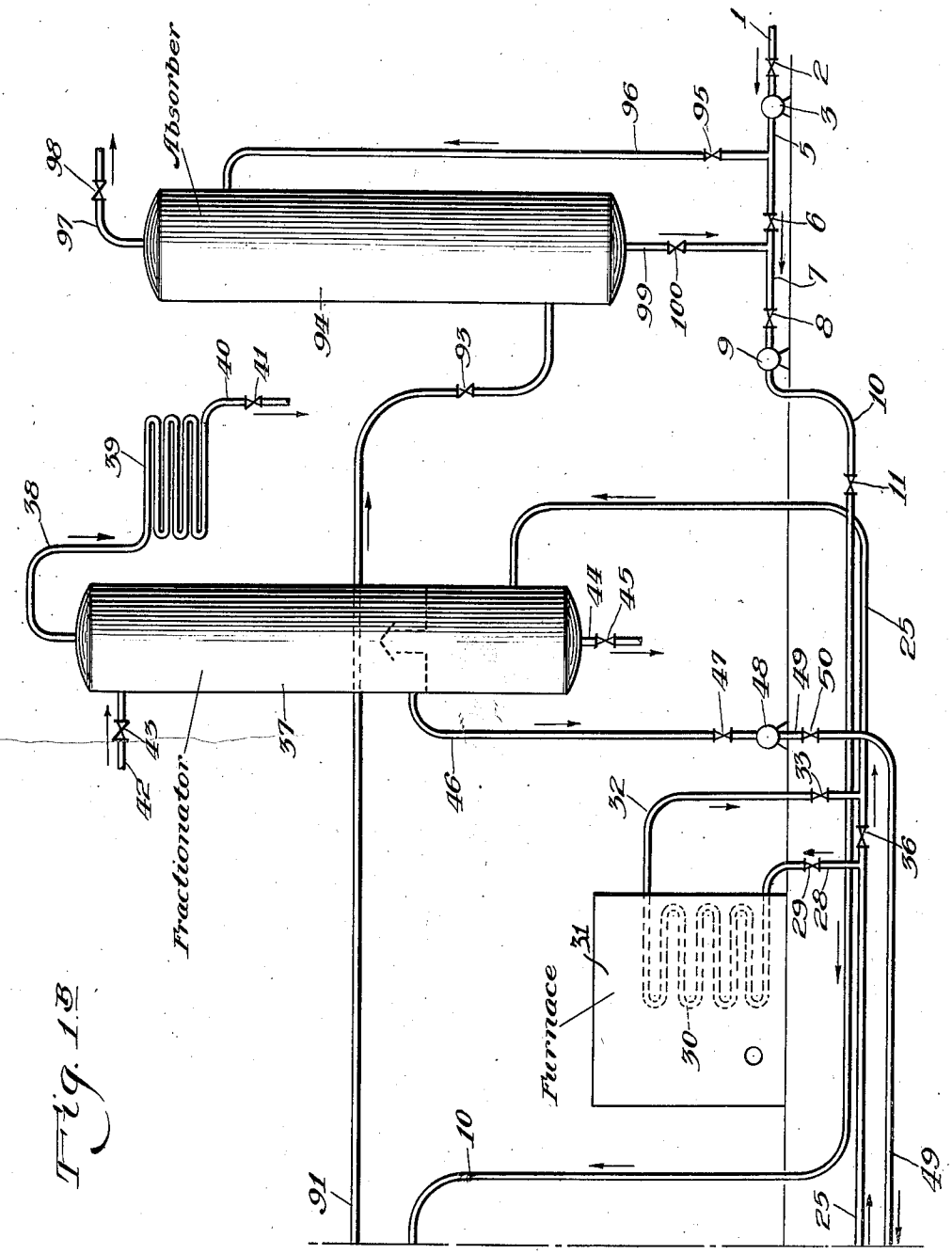


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UNITED STATES PATENT OFFICE

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PROCESS OF HYDROCARBON OIL CONVERSION

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Application November 19, 1930, Serial No. 496,590

3 Claims. (Cl. 196—67)

This invention relates to the treatment of hydrocarbon oils, and more particularly it pertains to the conversion of higher boiling hydrocarbons into lower boiling hydrocarbons.

In one of its forms the invention relates to a process wherein an oil to be treated undergoes conversion in the presence of hot gaseous products of combustion.

In a more specific form, the invention refers to the treatment of charging oil under suitable cracking conditions in the presence of gaseous products of combustion, the cracked products being treated to effect a separation of liquid and vapors, the vapors being intermingled with fixed hydrocarbon and combustion gases, suitable heat exchange being effected between the charging oil and cracked products to effect heat economy and to assist in the separation of the various components thereof.

The invention will be better understood by reference to the drawings which are illustrative of a form of apparatus capable of being utilized in the practice of the invention.

In the drawings, the raw oil to be treated is introduced through line 1 controlled by valve 2 into the charging pump 3. A portion, or if desired, all of the oil passes through line 5 controlled by valve 6, through line 7 controlled by valve 8 into pump 9 from which it is pumped through line 10 controlled by valve 11, into a fractionating column 13 in which the lighter fractions contained in the charging oil are removed. Reflux and raw oil are removed from the column 13 through line 14 controlled by valve 15, to pump 17, and is pumped through valve 18 and line 19 to indirect heat exchanger 20. From the heat exchanger the oil passes through line 21, controlled by valve 22 to pump 24, the oil being pumped through line 25 controlled by valve 26.

If the oil in line 25 does not contain sufficient heat for vaporization, it may be passed in whole or in part through line 28 and valve 29 into heating element 30 in a suitable furnace setting 31. From the heating element it passes through line 32 controlled by valve 33 back into line 25. A portion or all of the oil may be bypassed through valve 36 in line 25 without going through heating element 30. The oil passes from line 25 into a vaporizing or stripping tower 37, the lighter hydrocarbons in the form of vapors going off through line 38 into condenser 39, and being drawn off to storage through line 40 and valve 41. The temperature of the vapor in tower 37 may be controlled by the introduction of a spray of cold oil introduced through line 42 controlled by valve 43. The lighter components of the oil passing into tower 37 will vaporize the heavier components precipitating to the bottom of the tower and being withdrawn through line 44 and valve 45. The intermediate fractions which vaporize in the lower part of tower 37 reflux in the upper portion of the tower, and the reflux condensate is drawn off through line 46 and valve 47 to pump 48, is pumped through line 49 and valve 50 to heating element 52 disposed in a furnace setting 54, in which the oil is heated to elevated temperatures which are preferably within the range at which mild cracking will occur, and the oil is preferably maintained at a pressure sufficient to maintain substantially liquid phase conditions.

From the heating element 52 the heated oil passes through line 55 controlled by valve 56. The oil may pass in whole or in part through line 58 and valve 59 into chamber 60, by operating valve 61. In the chamber the heavy unvaporized residue settles at the bottom and is withdrawn through line 62 and valve 63, the vapors passing out of the chamber through line 64 and valve 65 into line 55. The oil may be bypassed around chamber 60 by closing valves 59 and 65, and opening valve 61. The hydrocarbons pass from line 55, preferably in the vapor state, through valve 67 into a perforated pipe or cone 68 disposed in a mixing chamber 69, which is connected with a combustion space 70 in which is burned fuel, preferably hydrocarbon gas or oil, introduced at 71, the products of combustion passing into chamber 69 through passage 72. The products of combustion mix with and heat the hydrocarbon vapors passing through pipe or cone 68, the additional heat imparted to the vapors raising the temperature of the vapors sufficiently to induce vapor phase cracking.

The gas-vapor mixture passes through vertical pipe 73 into chamber 74 in which the mixture is permitted to react for a sufficient period of time to effect the desired degree of conversion, the vapors and gases pass downwardly through the chamber 74 and outwardly through pipe 75 controlled by valve 76 into the lower part of the fractionating tower 13. The vapor-gas mixture is partially condensed by heat exchange with the relatively cold oil in exchanger 20, the heavy condensate being withdrawn at the bottom of the tower through line 77 controlled by valve 78. All of the condensate may be withdrawn to storage through line 79 and valve 80, or a portion or all of it may pass through line 81, valve 82, pump 83, line 84, valve 85 and line

19 into the heat exchanger 20. The vapors and gases evolved in the tower 13 are partially cooled in the upper portion of the tower, the reflux condensate being withdrawn together with the unvaporized portion of the charging oil through line 14, valve 15, pump 17 and valve 18, and passes into the heat exchanger 20 through line 19 where it joins any heavy condensate from tower 13 which may have been diverted into the heat exchanger.

The uncondensed vapors and gases in tower 13 pass out at the top of the tower through line 86, valve 101 and pump or compressor 102 and may be further cooled by passing through line 87 and valve 88 into cooling coils 89, passing through valve 90 into line 91. Or the gas-vapor mixture may be bypassed in whole or in part around the cooler by closing valves 88 and 90, and opening a valve 92 in line 86 which leads into line 91. Line 91 controlled by valve 93 leads to an absorption tower 94 in which the gas-vapor mixture is scrubbed by a countercurrent flow of cold oil led from line 5 through valve 95 and line 96 and sprayed into the upper part of the absorption tower. In this tower the gases are scrubbed substantially free of hydrocarbon vapors and entrained hydrocarbon particles. The uncondensable gases pass out of the top of the tower 94 by means of pipe 97 and valve 98, the raw oil and condensed vapors being drawn off through line 99 and valve 100, joining the oil stream passing through pipe 7.

The above description is to be understood as not limiting the scope of the invention, the apparatus and process which have been described being capable of wide variation without departing from the spirit of the invention.

Pressures employed within the system may range from sub-atmospheric to super-atmospheric pressures of several hundred pounds per sq. in. Substantially equalized pressure may be employed throughout the system or differential pressures may be utilized between the various elements. Conversion temperatures employed may range from 800° to 1300° F., more or less.

As a specific example of the operation of the improved process of the present invention a 34–35° A. P. I. gravity gas oil is fed through the absorber into fractionator 13, passing thereafter together with the reflux condensate from the upper portion and the unvaporized heavier oil from the lower portion of this zone through heat exchanger 20 and through heating element 30 to fractionator 37. Heating element 30 is maintained under a super-atmospheric pressure of about 100 pounds per sq. in. and the oil passing therethrough is heated to a temperature of approximately 700° F. Fractionating column 37 is maintained under substantially atmospheric pressure. Unvaporized residual oil is withdrawn from the lower portion of the fractionator 37 and reflux condensate from the upper portion of this zone is supplied to heating element 52 where it is raised to a temperature of approximately 750° F. under a superatmospheric pressure of about 100 pounds per sq. in. A reduced pressure of about 30 pounds per sq. in. is maintained in chamber 60 and this pressure is substantially equalized throughout that portion of the cracking system comprising the combustion zone, the mixing chamber, the reaction chamber and fractionator 13. Absorber 94 is maintained under a superatmospheric pressure of about 30 pounds per sq. in. The temperature of the admixed combustion gases and hydrocarbons entering chamber 74 is approximately 1025° F.

This operation may yield approximately 50 percent of motor fuel having an anti-knock value equivalent to a blend of approximately 75 percent benzol and 25 percent Pennsylvania straight-run gasoline. About 13 percent pressure distillate bottoms and some 22% of good quality fuel oil may represent the other liquid products from the system. No substantial amount of coke is produced and the 15 percent or thereabouts of gas may have a liquid hydrocarbon entrainment of about 3 percent or less on the basis of the oil treated, as compared with a loss of this nature totaling 5 per cent or more encountered in other types of vapor-phase cracking processes wherein hydrocarbons are mixed with hot combustion gases.

Having thus described my invention, I claim:

1. A conversion process which comprises cracking hydrocarbon oil in a cracking zone by direct contact with heating gases, thereby forming a mixture containing gasoline and heavier vapors and gas, cooling said mixture to condense at least a portion of the heavier vapors by indirect heat exchange with a cooling medium, subsequently scrubbing the remaining mixture with charging oil for the process and condensing the gasoline vapors in the charging oil, utilizing the resultant mixture of charging oil and condensed gasoline as said cooling medium thereby preheating the mixture, distilling the thus preheated mixture to separate the gasoline as vapor from fractions of the charging oil heavier than gasoline, supplying at least a portion of said fractions to the cracking zone for cracking treatment therein, and condensing the last-mentioned vapor as a product of the process.

2. A conversion process which comprises cracking hydrocarbon oil in a cracking zone by direct contact with heating gases, thereby forming a mixture containing gasoline and heavier vapors and gas, cooling said mixture to condense at least a portion of the heavier vapors by indirect heat exchange with a cooling medium, subsequently scrubbing the remaining mixture with charging oil for the process and condensing the gasoline vapors in the charging oil, utilizing the resultant mixture of charging oil and condensed gasoline as said cooling medium thereby preheating the mixture, heating the resultant mixture of charging oil and condensed gasoline sufficiently to vaporize the latter and a substantial portion of the charging oil, fractionating the vapors thus formed to separate the vaporized portion of the charging oil from the vaporized gasoline, and supplying said portion of the charging oil to the cracking zone for cracking treatment therein.

3. A conversion process which comprises cracking hydrocarbon oil in a cracking zone by direct contact with heating gases thereby forming a mixture of vapors and gases, scrubbing a portion of said mixture of vapors and gases with fresh charging oil for the process and condensing in the charging oil sufficiently and insufficiently cracked fractions of the vapors, passing the resultant mixture of charging oil and condensed sufficiently and insufficiently cracked fractions in heat exchange relation with said mixture of vapors and gases and supplying admixed vapors and gases uncondensed by the heat exchange to the scrubbing step, heating the resultant mixture of charging oil and condensed sufficiently and

insufficiently cracked fractions to vaporize said condensed fractions and a substantial portion of the charging oil, fractionating the vapors thus formed to separate the insufficiently cracked fractions and the vaporized portion of the charging oil as condensate from the sufficiently cracked fractions in the form of vapors, separately condensing the vapors of the sufficiently cracked fractions as a product of the process, and supplying said condensate containing the insufficiently cracked fractions to said cracking zone for contact with heating gases therein.

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