May 10, 1932. C. P. DUBBS **1,857,533**

METHOD OF TREATING HYDROCARBONS

Original Filed Feb. 17, 1921 2 Sheets-Sheet 1

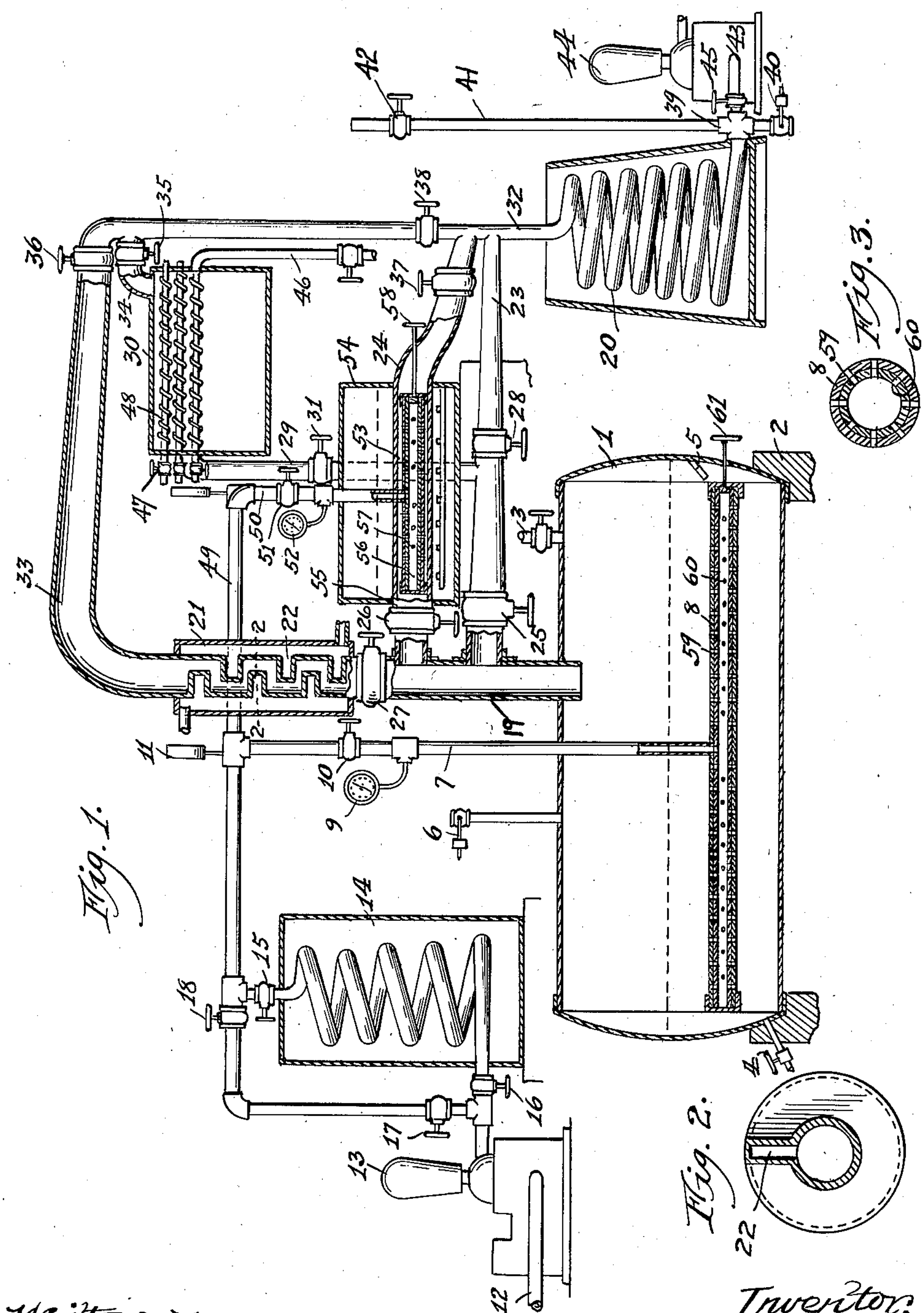

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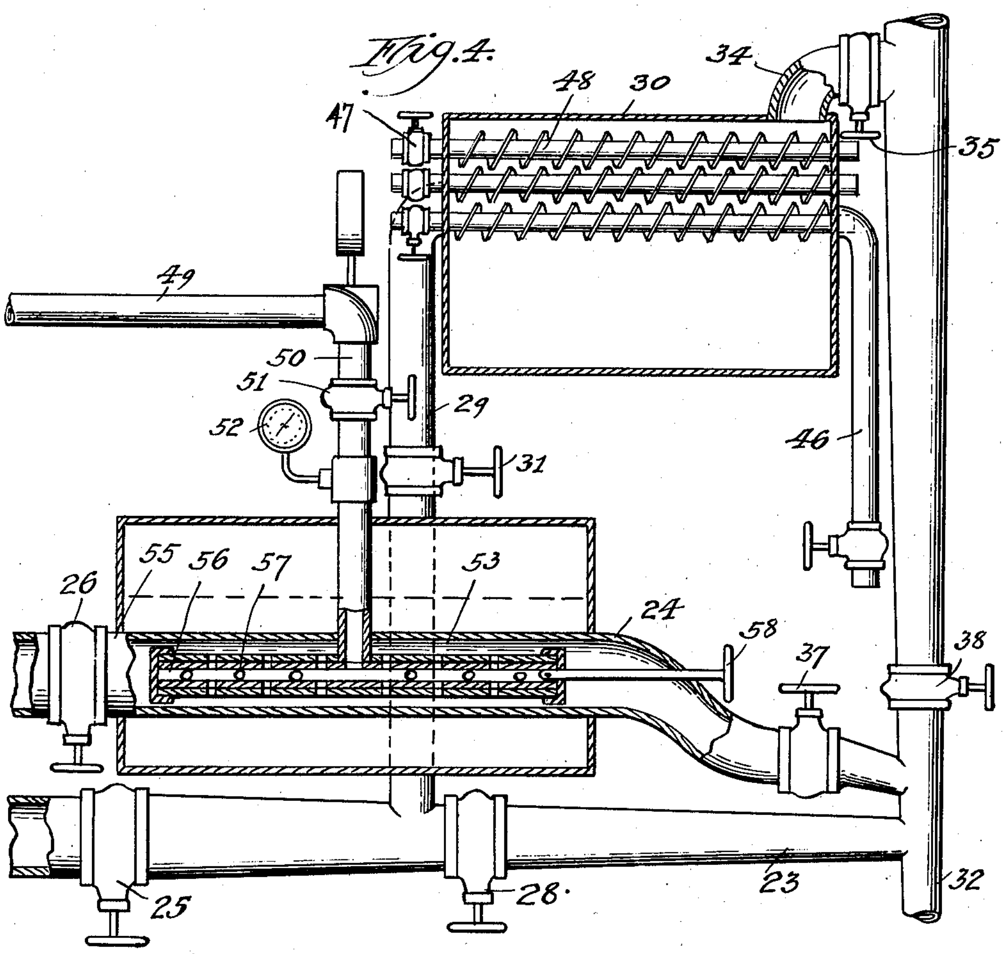
Fig. 4.



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UNITED STATES PATENT OFFICE

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METHOD OF TREATING HYDROCARBONS

Continuation of application Serial No. 445,669, filed February 17, 1921. This application filed March 3, 1927. Serial No. 172,536.

This application is a continuation of my copending application Serial No. 445,669, filed February 17, 1921, which application is in part a continuation of an original application filed by me on November 18, 1914, Serial No. 872,698.

This invention relates to a method of cracking hydrocarbon oils, such as the residue therefrom, and the particular application of the present invention is directed to the cracking of hydrocarbon oils, whereby the heavier portions thereof will be converted into lower boiling point portions or those of higher Baumé gravity.

Among the objects of the invention are to provide a process in which the oil to be cracked is treated in first one receptacle or heating pool and then in a separate receptacle or zone and in which the oil in each receptacle or zone may be independently heated; to provide a process in which the oil in each zone may be subjected to the action of gases independently controllable relative to each zone; to provide a process in which both the volume and the pressure of the gases in each zone may be varied relative to each other; to provide a process in which the oil in the second zone may take the form of vapors introduced from the first zone; to provide a process in which the hydrocarbon constituents of the second zone may be heated to either a temperature higher or lower than the temperature of the oil in the first zone or heating pool and in general to provide an improved process of the character referred to.

In the drawings:

Fig. 1 is a diagrammatic side elevation of the apparatus partly in section.

Fig. 2 is a sectional view of a portion of the apparatus taken on line 2—2 of Fig. 1, but on an enlarged scale in order to more clearly bring out details of construction.

Fig. 3 is a cross section through one of the baffle plate tubes.

Fig. 4 is a cross section showing the control of the perforated pipe.

Referring in detail to the drawings, in order to more clearly understand the use of the entire apparatus, it will be advisable to describe the various processes for which the apparatus can be utilized, although it is to be understood that I am here claiming only the conversion of high boiling point to lower boiling point oils. 1 designates the still supported directly over the furnace lugs 2, although various other means for heating the still might be employed. At the upper end the still is provided with a filling connection 3, and near the bottom with a drawoff cock 4. There is preferably also provided a pyrometer wall 5 and a weighted safety valve 6, all of these parts being of standard construction. Extending downward into the still is a gas pipe 7 connected at its lower end with a horizontally extending perforated pipe 8. The pipe 7 is provided with a suitable pressure gauge 9 and a cutoff valve 10, while extending into the tube from its upper end is a pyrometer 11. This pipe 7 is connected to a supply pipe 12 leading from a suitable source of supply of gas, such as natural gases, which it is desired to inject into the contents of the still 1 through the perforated pipe 8. In certain instances, it may be desirable to increase the pressure under which the substance is forced out of the perforated pipe 8 to a greater pressure than that under which the source of supply is maintained, and for this purpose a pump 13 is employed, although if desired, the pipes 12 and 7 may be connected by a by-pass (not shown) around the pump 13 in the usual manner. In order to provide for raising the temperature of the substance injected into the still contents, a superheater 14 is employed in the connection between the supply pipe 12 and the pipe 7, although the superheater can be cut out of the circuit by closing the valves 15 and 16 and opening the valves 17 and 18. From the above description it is obvious that the substance ejected from the pipe 8 into the contents of the still may be forced out into the pipe 8 at any desired pressure or temperature.

Leading from the top of the still is a gooseneck 19 which connects with the condenser 20 in a plurality of ways hereinafter described in detail.

Positioned in the upright of the gooseneck 19 is a reflux condenser 21, this condenser comprising a plurality of water baffles 22 around which circulate a water or other temperature controlling medium. Leading from the upright of the gooseneck 19 at a level below that in which the reflux condenser 21 is located, are laterals 23 and 24, entrance from the gooseneck 19 to these laterals being controlled by valves 25 and 26, and the entrance from the gooseneck 19 to the reflux condenser being controlled by similar valve 27. In addition to the valve 25 the lateral 23 is provided with a second cutoff valve 28 positioned just beyond the upright 29 which connects the laterals 23 with an air condenser 30. Communication between this air condenser and the lateral 23 is controlled by cutoff valve 31. Each of the laterals 23 and 24 connect with the upright line 32, and the air condenser 30 and reflux condenser 21 are also provided with connections to this line by vapor pipes 33 and 34, the latter having a valve 35 and the former a similar valve 36. Additional valves 37 and 38 are provided in the lateral 24 and vapor line 32.

The condenser 20 at its discharge end is provided with a coupling 39 from the lower end of which is a discharge opening controlled by weighted valve 40. By adjusting the valve 40 any desired back pressure may be put on the still and condenser as is known in the art. This would permit subjecting the oil to a higher temperature as with pressure, the normal boiling points of the hydrocarbons will be raised. Leading from the upper end of the coupling 39 is an escape pipe 41 controlled by suitable valve 42. In addition to these connections the coupling 39 has a lateral pipe 43 connected with a vacuum pump 44. A valve 45 is employed for cutting off the pump, and both the pump and weighted valve control outlet lead to a suitable storage tank or other receptacle (not shown).

In treating liquids which give a distillate having boiling points higher than water, the vapors are, by adjusting the valves 28 and 31, forced to pass through the air condenser 30 against baffle plates 48 which condense such distillates as have boiling points higher than water. Condensed distillates are collected into the bottom of the air condenser and overflow out of pipe 46 to suitable storage, the air condenser being maintained at a temperature above the boiling point of water by opening or closing the valves 47 on the baffle plate tubes 46, which are spirally corrugated. The uncondensed oils and uncondensable gas pass through pipe 34 into vapor line 32 and into condenser 20.

Describing now the manner of heating the oil in the second zone, the supply pipe 12 and extension 49 are connected to a second upright 50 by an L, the latter being provided with a control valve 51 and pressure gauge 52. At its lower end the upright 50 discharges into a perforated pipe 53 similar to the perforated pipe 8 employed in the still. The perforated pipe 53 is located in the lateral 24 and the latter is surrounded by a furnace 54, (diagrammatically shown) the gas jets being omitted to avoid complicating the drawings, whereby its temperature may be raised if desired. The temperature of the vapors at the time they pass into the lateral 24 is determined by a pyrometer which can be placed at the point marked 55, while the size of the openings 56 in the perforated pipe 53 is controlled by means of a rotary sleeve valve 57 which is operated by an exterior stem 58. In a similar manner the discharge through the openings 59 in the pipe 8 is controlled by a valve 60 operated by a stem 61. The purpose of this valve is to permit the total cross-sectional area of the discharge openings being increased or diminished to regulate the velocity of the injected substance without changing the quantity which is being discharged into the substance treated; that is, the volume discharged through the openings 59 or 56 can be maintained constant while increasing the velocity with which the injected substance is discharged into the substance treated.

The following method of carrying out the process in cracking oils may be used: Valves 25 and 26 may be closed, and valve 27 opened, valve 36 opened, valve 35 closed, valve 38 opened and the pressure controlled by the weighted valve 40 on the outlet side of the condenser. In this method of carrying out the process, the second zone formed by the pipe 24 is not used. The vapor pressure on the system may be maintained at from 100 to 750 pounds, by suitably regulating the valve 40 and the gas outlet valve 42. An uncondensable gas, such as natural gas, may be introduced into the perforated pipe 8 through the line 7. A gas pressure of say, 1000 pounds, may be maintained on the line 7 above the valve 10. The volume of gas introduced will be controlled by the valve 10. The pressure (which controls the velocity) will be controlled by the valve 60. For example, it may be desired to let in 500 cubic feet of gas per minute at a pressure of 200 pounds, which at the outset, can be accomplished by suitably regulating the valves 10 and 60, since during the next stage of the operation as the lightest constituents have distilled off, the same amount of gas may be introduced but the pressure raised to 250 pounds by further throttling the valve 60. In the next stage of the operation, the same volume of gas may be maintained and the pressure raised to 300 pounds by further throttling the valve 60. The temperature to which the oil may be heated may be from 750 to 900 degrees F.

It will be clearly understood by those skilled in the art that the vapor pressure, gas pressure and volume of gas and oil temperature will all vary widely with the character of the oil being treated and the desired gravity of pressure distillate to be obtained.

The heavier vapors may be returned by the reflux condenser to the still for further treatment.

As an additional method of carrying out the process adapted for use in this apparatus, the valves 25 and 27 may be closed and the valve 26 opened. The valve 37 may also be opened and the pressure controlled on the outlet side of the condenser as before. In this method, the oil in the still may be treated in identically the same way as before, but now the vapors will be independently heated in the zone or container 24 and if desired, may be superheated. In addition, the volume of gas introduced may be less than that in the main still 1, but the pressure on the gas entering the second zone may be maintained at say, in the first stage, 300 pounds, the second stage, 350 pounds and the third stage at 400 pounds, by suitably regulating the valve 58. It is to be understood, however, that the vapor pressure on the oil is controlled from the outlet side of the condenser and is in fact not controlled in any way by the pressure at which the gas is introduced.

In converting the higher boiling point oils to lower boiling point oils, such as in making gasoline from high boiling point residuums or distillates, the valves 25 and 26 are closed, and the valve 27 opened. The vapors then in passing to the condenser 20 are compelled to pass through the reflux condenser 21, the temperature at which this condenser is maintained being such as to condense and return to the still those vapors that do not have a low enough boiling point. In place of sending the vapors through the reflux condenser the latter may be cut out by closing valve 27 and the vapors compelled to pass through the lateral 24 where they may be subjected to the action of a substance injected through the perforated pipe 53. The temperature and pressure of the injected substance is sufficiently high to result in lowering the boiling point of the vapors treated.

A further method of cracking oil in this apparatus may be described as follows: The whole system may be maintained under a predetermined pressure by regulating the outlet side of the condenser and either an uncondensable gas or other substance may or may not be introduced into the receptacle 1. The vapors, however, which pass into the receptacle 24 may be subjected to the action of uncondensable gas and introduced under a given pressure and volume to permit the gas to enter the chamber 24.

I claim as my invention:

1. A process for cracking heavy hydrocarbon oil for the production of gasoline-like hydrocarbons which comprises introducing the oil to an initial heating zone and heating the same therein to a temperature sufficient to effect substantial vaporization of the oil, passing the evolved vapors to a super-heating zone to which no liquid oil from said initial heating zone is admitted, superheating a permanent hydrocarbon gas independently and exteriorly of said initial heating zone and said superheating zone, introducing the superheated gas directly and without previous passage thru said initial heating zone to said superheating zone and into physical contact with the vapors therein, superheating the vapors in said superheating zone to a temperature materially in excess of that maintained in said initial heating zone and in the absence of liquid oil from said initial heating zone, removing the superheated vapors and said gas from said superheating zone and cooling the same sufficiently to condense said vapors out of the gas, and collecting the resultant distillate as the final product of the process.

2. A hydrocarbon oil cracking process which comprises introducing the oil to a distilling zone and heating the same therein to a cracking temperature under superatmospheric pressure, passing the evolved vapors free of liquid oil from said distilling zone to a superheating zone, superheating a permanent hydrocarbon gas independently and exteriorly of said distilling and superheating zones, passing one portion of the superheated gas thru the liquid oil in said distilling zone, passing another portion of the superheated gas directly and without previous passage thru said distilling zone to said superheating zone and into physical contact with the vapors therein, superheating the vapors in said superheating zone to a temperature in excess of the cracking temperature maintained in said distilling zone, removing the superheated vapors and said gas from said superheating zone and cooling the same sufficiently to condense said vapors out of the gas, and collecting the resultant distillate as the final product of the process.

3. A process for cracking heavy hydrocarbon oil for the production of gasoline-like hydrocarbons which comprises introducing the oil to an initial heating zone and heating the same therein to a temperature sufficient to effect substantial vaporization of the oil, passing the evolved vapors to a superheating zone to which no liquid oil from said initial heating zone is admitted, superheating a gaseous material independently and exteriorly of said initial heating zone and said superheating zone, introducing the superheated gaseous material directly and without previous passage thru said initial heating zone to said superheating zone and into physical contact with the vapors therein, the temperature and pressure of the superheated gaseous material injected into said superheating zone being sufficiently high to effect a lowering of the boiling point of the

vapors therein, removing the converted vapors from said superheating zone and subjecting the same to condensation.

4. A process for cracking heavy hydrocarbon oil for the production of gasoline-like hydrocarbons which comprises introducing the oil to an initial heating zone and heating the same therein to a temperature sufficient to effect substantial vaporization of the oil, passing the evolved vapors to a superheating zone to which no liquid oil from said initial heating zone is admitted, superheating incondensible hydrocarbon gas independently and exteriorly of said initial heating zone and said superheating zone, introducing the superheated incondensible hydrocarbon gas directly and without previous passage thru said initial heating zone to said superheating zone and into physical contact with the vapors therein, the temperature and pressure of the superheated incondensible hydrocarbon gas injected into said superheating zone being sufficiently high to effect a lowering of the boiling point of the vapors therein, removing the converted vapors to said incondensible hydrocarbon gas from said superheating zone and cooling the mixture sufficiently to separate the vapors from the gas by condensation.

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