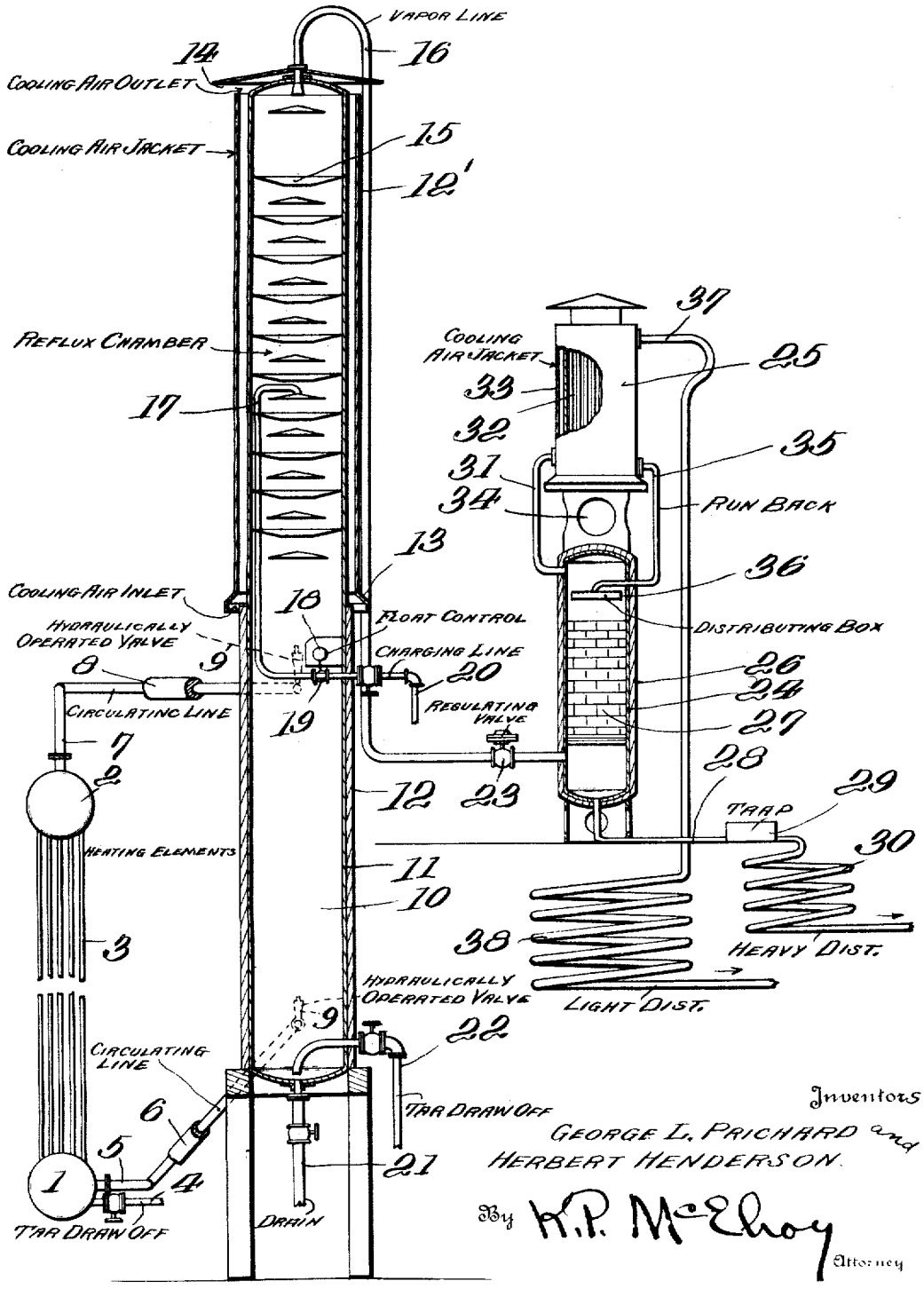
April 28, 1931. G. L. PRICHARD ET AL 1,802,531

CRACKING PROCESS

Filed July 6, 1923



Inventors
GEORGE L. PRICHARD and
HERBERT HENDERSON.

By H. P. McElroy
Attorney

Patented Apr. 28, 1931 1,802,531

UNITED STATES PATENT OFFICE

GEORGE L. PRICHARD AND HERBERT HENDERSON, OF PORT ARTHUR, TEXAS, ASSIGNORS TO GULF REFINING COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF TEXAS

CRACKING PROCESS

Application filed July 6, 1923. Serial No. 649,920.

This invention relates to cracking processes; and it comprises a method of cracking relatively heavy petroleum oils to produce vapors of relatively light petroleum oils therefrom in which a column of oil of substantial height is established and maintained under suitable pressure in a vertical casing, the lower portion of said casing containing said column being unobstructed and in free and open communication with the upper portion of the casing, establishing and maintaining a regulable circulation of oil from and to said column through suitable outside heating elements regulably cooling the upper portion of said casing, delivering new oil at a point in said upper portion substantially above the normal oil level of said column, but below the top of the casing and removing vapors from the top of the casing and filming out the new oil so delivered and the condensed oils formed by cooling in intimate contact with the vapors passing upward through the upper portion of the casing to the point of vapor exit; and it also comprises certain assemblages of apparatus elements adapted for use in the performance of said process; all as more fully hereinafter set forth and as claimed.

In the cracking of heavy oils for the production of lighter oils, such as gasoline, it is well understood that the results may be attained by superheating the oil, either in the liquid state or as vapors. In working with liquid oil, it is customary to use pressure, in order to maintain the oil liquid at the temperature used. It is convenient to work with liquid oil rather than vapor, because of the small size of the apparatus required for a given output and for other reasons. In heating a body of oil under pressure to a cracking temperature, the vapors evolved represent original or uncracked oil, as well as the lighter vapors produced by cracking. In all installations cracking oil in the liquid state, it is therefore customary to use some type of reflux or cooling arrangement by which these heavier and higher boiling oils can be condensed and returned for reheating, while the vapors of lighter products go on to appropriate condensers. Usually, these reflux condensers are structurally separate from the still and are connected with it by piping. Sometimes, the outgoing vapors and the returning oil pass through the same conduit between the still and reflux arrangement. Sometimes, they go through separate conduits. Both arrangements have their conveniences and inconveniences.

In the cracking of oil there is inevitably formed a certain amount of carbon as coke; and this tends to deposit on the heating elements, baking thereon if given any opportunity and impeding the transmission of heat as well as necessitating a shut-down occasionally to chip the coke off the pipes or plates.

In the present invention, we have rearranged conditions to secure a methodical cracking and refluxing in a single piece of apparatus with the refluxing arrangement in unobstructed communication with the distilling arrangement. In cooling the vapors in the refluxing arrangement, heat units are dissipated; to this extent necessarily increasing the amount of heat which must be added to the oil in distillation. It is one of the objects of this invention to so control the proportion between the heat units so dissipated and the heat units added as to prevent loss of energy; and to this end we employ both a regulable cooling of the reflux portion of the apparatus and regulable heating of the distilling portion. To this end, we make the heating elements structurally separate from the portion of the apparatus wherein distillation occurs; using tubular heating elements extending from the cracking apparatus to and through a suitable furnace. In order to further conserve heat and for other advantageous reasons, we deliver the incoming new oil to the system in washing contact with the vapors on their way to the condens-

ers; that is, in the reflux portion of the apparatus but below the top. As noted, the reflux portion of the apparatus is in free and open communication with the distilling portion, so that this addition of oil can be made in this way without difficulties due to regurgitation, etc. In order to control the cooling of the upper or reflux portion of the apparatus, we generally provide it with an air jacket through which a regulable circulation of air takes place. Other regulable cooling means may be employed, but this is convenient and desirable.

In the best embodiment of our invention at present known to us, we establish and maintain a vertical column of oil in a relatively tall, narrow tubular casing, the normal oil level of the column being controlled by suitable float means. Below the normal oil level, the casing is open and unobstructed, to permit free settling and deposition of carbon. One or more lateral furnaces are provided containing tubes or tube nests, through which oil may be circulated from the column through the heater and back to the column. Above the normal oil level within the casing, we generally provide baffles of some type for the purpose of filming out condensed returning oil in effective contact with passing vapors. The use of baffles is better than that of packing, for the reason that there is no tendency to cause friction or pressure differentials within the apparatus. It is our aim to have the same pressure prevail throughout the reflux portion of the apparatus and the distilling portion. At some midpoint in the height of the casing, above the normal oil level, we provide inlet means for delivering new oil to the system; this new oil being delivered to the baffles in such a way as to be filmed out in contact with the passing vapors. In so doing, the new oil acts as a scrubbing means for the condensing heavy vapors and is itself heated, but does not interfere with the refluxing function of the top part of the casing. The base of the casing is provided with clean-out means and with an outlet for removing residual oil, either continuously or from time to time.

In the accompanying drawings, we have shown a view in vertical section (parts being in elevation) of one form of apparatus capable of performing our process and within the purview of our invention. Referring to the drawings, 1 indicates a lower drum and 2 an upper drum connected by vertical tubes 3 forming the heating elements. The details of the furnace structure and the details of the tubes and drums are not illustrated. A furnace and heating elements such as shown in our copending application Serial No. 541,126, which has matured into Patent No. 1,734,837, may be used. The lower drum is provided with the valved tar drawoff 4 and with the inlet line 5 insulated throughout its length by insulation 6 (broken away for clarity of illustration). Leading from the top of the upper drum 2 is circulating line 7 carrying insulation 8 (also broken away for clarity of illustration). Both of the circulating lines 5 and 7 are provided with hydraulically operated valves 9 at points outside of the casing to be described. In case one or more of the tubes of the heating element break and in case it is necessary to shut down for repairs or cleaning purposes, these valves may be operated from a distant point to shut off supply of oil from the casing to the heating elements. The casing designated as a whole by reference numeral 10 comprises a steel shell 11 suitably insulated by asbestos, sil-o-cel or the like 12 to a point advantageously above the normal liquid level of the oil therein and is arranged for air cooling at the top, in order that there may be suitable refluxing. The upper casing or reflux portion is advantageously of the same internal cross section as the lower portion of the casing containing the liquid oil. It may be provided with a cooling jacket 12^1, air for cooling entering at 13 and passing out at 14 by natural draft, dampers (not shown) being provided if desired. This construction permits cooling of the upper part of the column to produce a limited degree of condensation. The casing is further provided with a plurality of baffle plates 15 for filming out added oil and condensed oil. At the top the reflux portion of the casing is provided with vapor line 16 and, at a point about midway, with incoming oil line 17 through which the oil is admitted over top of a series of the filming plates in amount and proportion controlled by the float 18 operating valve 19 on the line 17. Oil under pressure is supplied to this line through pipe 20 and its admission is controlled by the float as described. The bottom of the casing is provided with drain 21 and with the tar drawoff 22, both being suitably valved. The vapor line 16 leads part regulating valve and pressure controlling valve 23 to the fractionating tower composed of two condensers 24 and 25. The lower condenser is provided with insulation 26 and with a filling of tile, tubes, baffle plates or the like 27 and at its bottom with line 28 leading past trap 29 to heavy distillate coil 30 for condensation of the heavy fractions. Vapors arising from the lower condenser 24 go by line 31 to the upper condenser 25 of the fractionating tower past a plurality of tubes 32 cooled by the air cooling jacket 33 and by air admitted through the ports 34. Condensate collects at the bottom and is returned to the lower condenser by means of run back line 35 to distributing box 36, whereby vapors ascending in the lower condenser are scrubbed by condensate from the upper condenser. Uncondensed vapors leave the upper condenser of the

fractionating tower by line 37 and are condensed as light distillate in cooling coil 38. These coils 30 and 38 are preferably water-cooled.

In operation, assuming heavy oil of the nature of gas oil is to be cracked, this oil is pumped into the heating elements at the lower portion of the casing past the hydraulic valve 9 on line 5 and heat is supplied by gas burners or the like in the furnace surrounding the heating elements 3. The oil is rapidly circulated from the casing through pipe 5, which is the colder leg, through the heating elements and through pipe 7, which is the hotter leg, back to the casing containing the column of oil. Preferably the oil from the heating elements is introduced below the top of the column of oil in the casing. Vapors released pass through a layer of oil and upwardly in the reflux tower portion of the casing, the outside of which is protected from the weather by the jacket 12^1, allowing air to pass through the air space thus provided. The heavy ends are condensed in this top portion and drop back into the lower portion of the casing and join the oil therein. Condensates collect on the baffle plates 15 and are filmed out so that the vapors from the column of liquid oil continuously pass over these condensates picking up light fractions. This affords very good heat exchange and scrubbing. In order to aid in condensing in this reflux portion of the casing, the added oil is admitted through the charging line 20, by way of 17, under pump pressure, onto the baffle plates at about the center of the baffle portion of the reflux section of the casing. Vapors which are not condensed pass through vapor line 16 where they are either released or reduced through pressure relief valve 23 into the bottom portion of the fractionating tower. These vapors pass up through the tile or tubes 27, and then to the bottom portion of the upper condenser 25 through line 31, then around the tubes 32 to the vapor line 37 from which they go to condenser 38 and thence to the receiving house as light distillate. The condensates in the upper portion of the fractionating tower go by line 35 to the distributing box 36 and scrub the vapors arising in the lower portion 24 of the fractionating tower and combine with the condensates in 24. The combined condensates form the heavy distillate which goes past trap 29 to heavy distillate condenser or cooling coil and thence to the receiving house.

The incoming oil or added oil is admitted under pressure through line 20 to the casing by line 17, but at a point, as stated, about midway of the reflux section of the casing and the admission of such incoming oil is controlled by means of the float inside this chamber operating the valve 19.

The temperature to which the oil is heated in the heating element varies with the pressure maintained throughout the system as far as the releasing valve 23. It is to be noted that according to this invention refluxed oil is passed back to the lower portion of the casing and to the heating elements without any obstruction, with the result that the total amount of distillate in a given time is considerably increased over known refluxing systems where there are vapor lines and back trap means or run back lines passing from a reflux to a still. A temperature of 750–800 degrees Fahrenheit in the heating elements with a pressure of 100 pounds maintained in the system has proved very satisfactory, although other temperatures and pressures may, of course, be used, depending upon the character of the oil being cracked, the character of distillation desired and other factors.

Through the process and with the use of the apparatus described, we are able to greatly increase the yield of light distillate over the usual practice, this, we believe, being due to the thorough refluxing which is possible by our invention, the thorough scrubbing of the vapors and the thorough heat interchange between outgoing vapors and incoming oil, and the regulation of added oil through the automatic means described, admitting oil in correct proportion to compensate for vapors removed from the reflux portion of the casing. While we have shown the pressure regulating valve before the fractionating tower or final condensers and while we have had very good results with the use of such arrangement, we may use pressure regulating valves on the lines 37 and 28, if desired.

According to this process, we have secured large yields (60–70 per cent) of gasoline from gas oil and exceptionally large yields of gasoline from distillate slightly lighter than gas oil with production of very little coke.

What we claim is:—

1. In the cracking of petroleum oils the process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, keeping the liquid column of oil constant by introduction of oil in amount proportionate to removal of the vapors under pressure at a point substantially thereabove and substantially below the upper extremity of said overlying vapor, preventing substantial loss of heat by radiation from the liquid oil of said column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and delivering heat to said liquid oil by cyclic circula-

tion of oil therefrom to heating means and back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

2. In the cracking of petroleum oils the process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, keeping the liquid column of oil supplied by introduction of oil under pressure about mid point in the overlying oil vapor, preventing substantial loss of heat by radiation from the liquid oil of said column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and delivering heat to said liquid oil by cyclic circulation of oil therefrom to heating means and back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

3. The process of cracking oil which comprises heating the same in a column form, passing the vapors below the normal liquid level of a body of oil to scrub such vapors, passing said vapors after such scrubbing to an enclosed space immediately above and in unobstructed communication with said body to partially condense the vapors, finally condensing uncondensed vapors from such space and maintaining the liquid level of said body of oil constant by supplying the same with fresh oil to be distilled at a point substantially above said body of oil and substantially below the top of said enclosed space in amount proportionate to the removal of the vapors therefrom by means controlled by the level of such body.

4. In the cracking of petroleum oils and process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, maintaining the liquid column of oil by introduction of oil under pressure at a point substantially thereabove and substantially below the upper extremity of said overlying vapor, preventing substantial loss of heat by radiation from the liquid oil of said column, preventing further heating of vapors escaping from said liquid column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and delivering heat to said liquid oil by cyclic circulation of oil therefrom to the heating means and back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

5. In the cracking of petroleum oils the process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, keeping the liquid column of oil supplied by introduction of oil under pressure at a point substantially thereabove, and substantially below the upper extremity of said overlying vapor, preventing substantial loss of heat by radiation from the liquid oil of said column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and delivering heat to said liquid oil by cyclic circulation of oil therefrom to heating means and redelivery of substantially all of the so heated oil back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

6. In the cracking of petroleum oils the process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, keeping the liquid column of oil supplied by introduction of oil under pressure at a point substantially thereabove and substantially below the upper extremity of said overlying vapor, filming out the oil on its way down through the vapor portion of the column to the liquid portion of the column, preventing substantial loss of heat by radiation from the liquid oil of said column, preventing further heating of vapors escaping from the liquid oil of said column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and delivering heat to said liquid oil by cyclic circulation of oil therefrom to heating means and back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

7. In the cracking of petroleum oils the process which comprises establishing and maintaining a substantially vertical column of liquid oil and overlying oil vapor in substantially unobstructed communication at cracking temperature and under cracking pressure, keeping the liquid column of oil supplied by introduction of oil under pressure at a point substantially thereabove and substantially below the upper extremity of said overlying vapor, filming out the oil on its way down through the vapor portion of the column to the liquid portion of the column, preventing substantial loss of heat by radiation from the liquid oil of said column and causing cooling of the vapors of said column to produce a limited degree of condensation above the point of introduction of the oil, and deliver-

ing heat to said liquid oil by a cyclic circulation of oil therefrom to a heating means and redelivery of substantially all of the so heated oil back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

In testimony whereof we have hereunto signed our names at Port Arthur, Texas, this 2nd day of July, 1923.

GEORGE L. PRICHARD.
HERBERT HENDERSON.

ing heat to said liquid oil by a cyclic circulation of oil therefrom to a heating means and redelivery of substantially all of the so heated oil back to the column of liquid oil, while removing and condensing uncondensed vapors from the vapor overlying the column of liquid oil.

In testimony whereof we have hereunto signed our names at Port Arthur, Texas, this 2nd day of July, 1923.

GEORGE L. PRICHARD.
HERBERT HENDERSON.

CERTIFICATE OF CORRECTION.

Patent No. 1,802,531. Granted April 28, 1931, to

GEORGE L. PRICHARD ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 63, for "1,734,837" read 1,734,827; same page, line 111, for "part" read past; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of June, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

CERTIFICATE OF CORRECTION.

Patent No. 1,802,531. Granted April 28, 1931, to

GEORGE L. PRICHARD ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 63, for "1,734,837" read 1,734,827; same page, line 111, for "part" read past; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of June, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)