

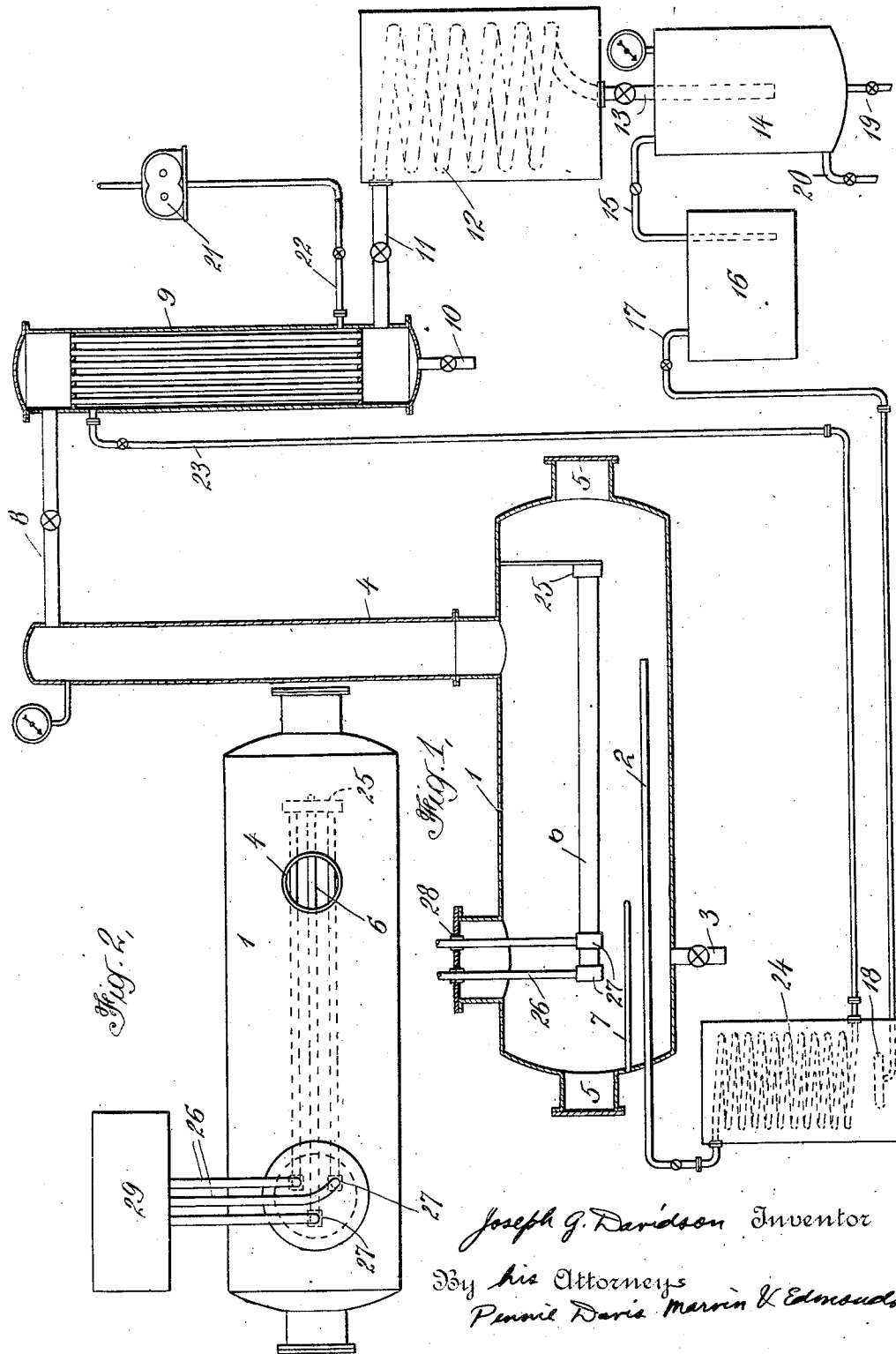
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J. G. DAVIDSON

METHOD OF CRACKING OILS

Original Filed June 10, 1920 2 Sheets-Sheet 1



Joseph G. Davidson Inventor

By his Attorneys
Perrin Davis Martin & Edmundson

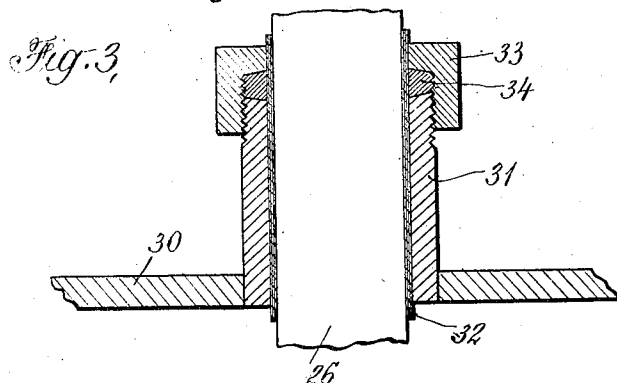
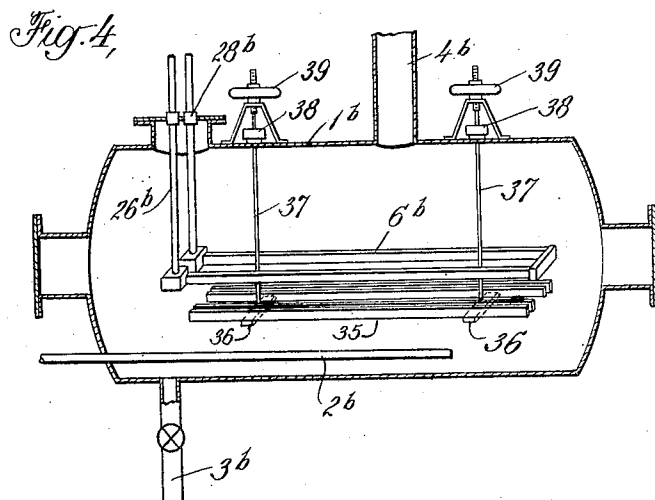
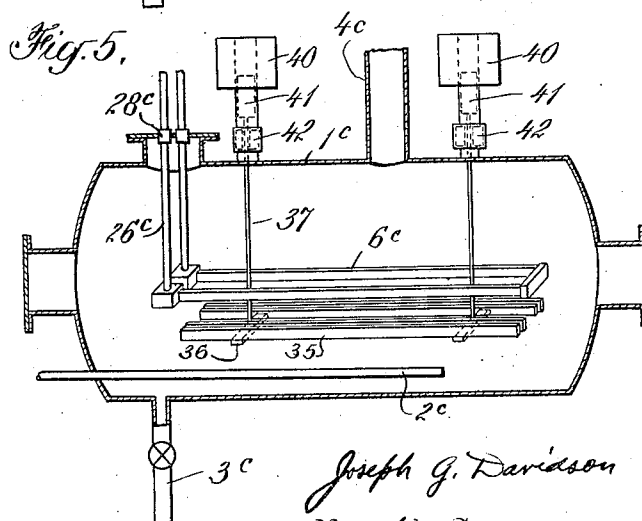
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UNITED STATES PATENT OFFICE.

JOSEPH GEORGE DAVIDSON, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO CHARLES H. CONNER, OF NEW YORK, N. Y.

METHOD OF CRACKING OILS.

Application filed June 10, 1920, Serial No. 387,967. Renewed October 24, 1922. Serial No. 596,685.

To all whom it may concern:

Be it known that I, JOSEPH GEORGE DAVIDSON, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny, State of Pennsylvania, have invented certain new and useful Improvements in Methods of Cracking Oils; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an improved method for the thermal decomposition or cracking of oils, such as the higher boiling petroleum fractions, for the production therefrom of gasoline and other products.

In the cracking of petroleum oils, for the production of gasoline, it has been proposed to effect the cracking by heating the oil in a closed retort by the application of external heat. In such procedures the effective heat must pass through the walls of the still or retort, and the still walls must be heated to a much higher temperature than that required for the cracking operation. Moreover, the inner walls of the still, at the place where the heat is applied, becomes coated with a layer of carbon, which interferes with the effective heat transfer and results in further overheating of the still walls, causing buckling and warping of the still walls with consequent danger of explosion, particularly if the operation is carried out under a high pressure. Moreover, in such apparatus, the pressure which can safely be maintained in the still is limited, due to the weakening of the still walls when overheated.

The present invention overcomes such objections and disadvantages and provides an improved method well adapted for use in the thermal decomposition or cracking of oil on a commercial scale. According to the present invention, the heat necessary for the cracking operation is generated by a heavy electric current of low voltage passing through one or more massive resistors, preferably of carbon, located away from the walls of the still, and such resistors are heated by an alternating current of suitable

character to the temperature required for bringing about effective cracking of the oil treated. The temperature of the resistors, in the process of the present invention, does not greatly exceed the temperature of the oil itself, although sufficient to heat the oil to the required temperature. The heat generated in this way is substantially all effective in the cracking operation and substantially all absorbed by the oil, the walls of the still remaining relatively cool and at a temperature which does not exceed that of the oil inside. The metal of the still therefore retains substantially its normal tensile strength, and the still is able to withstand correspondingly higher pressures with safety, whereas the external heating of a still to the temperature required for cracking, which is in the neighborhood of incipient redness, decreases the strength of the still to about half its normal strength, and correspondingly reduces the internal pressure which the still can safely withstand. In the apparatus for carrying out the present invention, the massive electrodes are spaced away from the walls of the still a sufficient distance to prevent heating of the still walls by induction, even though a heavy current is used, so that there is no cracking taking place where the oil contacts with the still walls, and therefore no objectionable deposition of carbon or coke on the still walls. Owing to the protection of the still walls from overheating, it becomes possible to use a lighter and more economical construction than is possible in an externally heated still. It will also be evident that for a still of given construction and tensile strength a much greater pressure can be safely used than in an externally heated still.

I am aware that it has been proposed to effect the cracking or conversion of oils by subjecting them to exceedingly high temperatures by means of an electric heater, such temperatures being exceedingly high as compared with temperatures commercially used. In the process of the present invention, however, the temperatures to which the oil is subjected do not exceed those commonly used in oil cracking operations, and the

temperature of the resistors which are submerged in the oil does not greatly exceed the temperature of the oil itself, and will usually be lower than the temperature of the walls of externally heated stills or retorts in which cracking operations are carried out.

In my investigation of the cracking of oil by the application of heat generated by an electric current I have found that the results obtained vary with variations in temperature and pressure as well as with the rate of distillation and the rate at which the electrical energy is supplied. These various factors are in part interdependent and themselves capable of some variation. I have thus found that the yield of gasolene obtained increases with increase in pressure up to a certain point, beyond which further increase in pressure does not result in corresponding increase in yield. In general, the yield of gasoline increases with increase in pressure from around 100 pounds per square inch up to about 200 pounds per square inch, and I have obtained best results with pressures around 160 to 200 pounds. This increase in the yield of gasolene due to increased pressure, results in a material decrease and economy in the electrical energy required per gallon of gasolene produced.

The rate of distillation, when the cracking and distillation is carried out under a high pressure and at a corresponding temperature, likewise has an important influence in the result obtained. In the operation of the process of the present invention, the oil to be cracked is brought to the proper pressure by the passage of a heavy electric current through the resistors and by confining the vapors until the pressure is built up to the required degree. The vapors are then released at substantially the same rate at which they are generated. In general, as the rate of distillation increases, the percentage of gasolene in the cracked material decreases, altho the actual number of gallons of gasolene produced per hour generally increases. So also, the electrical energy necessary per gallon of gasolene produced varies with the rate of distillation. For example, if the capacity of the retort or still in gallons is divided by the rate of distillation in gallons per hour and the result obtained be considered the time factor, then, as the time factor increases, that is, as the rate of distillation decreases, the energy necessary per gallon of gasolene produced will decrease until the time factor is in the neighborhood of one, that is, until the rate of distillation per hour is about equal to the capacity of the retort. If the time factor is still further increased, that is, if the rate of distillation is still further reduced, the energy necessary per gallon of gasolene produced will again increase. The optimum time

factor will vary somewhat with variations in other conditions of operation, but the investigations that I have made indicate for best results that the rate of distillation per hour should approximate or be somewhat less than the capacity of the still itself, although it will be evident that the rate of distillation is capable of considerable variation.

In the practice of the present invention it is of advantage to preheat the oil entering the cracking still by subjecting it to heat interchange with the hot distillate thereby also effecting a preliminary cooling of the distillate. This preheating of the oil entering the cracking still can be further supplemented if necessary so that the oil enters the still preheated to a temperature approximating that maintained in the still and required for the cracking operation. The preheating of the oil in this way effects an important economy in the electrical energy required for the cracking operation, and makes unnecessary the use of electrical energy for preheating the oil.

The present invention is applicable to the thermal decomposition or cracking of various oils or oil fractions, more particularly the higher boiling fractions of petroleum oils, either of the paraffin or asphaltum or mixed base series, for the production therefrom of gasolene and other products. It is one advantage of the process of the present invention that the amount of permanent gas produced is very small, while the amount of gasolene is relatively large, and the other products of the process are themselves for the most part of lighter gravity than the original oil. In general, the heavier fractions of petroleum, when treated according to the present invention, give higher yields of gasolene at the same expenditure of electrical energy than the lighter fractions, that is, heavy gas oil or heavy paraffin oil gives higher yields of gasolene than light gas oil. The residue remaining after the distillation of the gasolene from the cracked material can be again subjected to the cracking process, but the yield of gasolene produced is materially lower and the electrical energy required per gallon of gasolene produced is higher than in the case of the original higher boiling petroleum fractions, such as heavy gas oil or heavy paraffin oil.

The invention will be further described in connection with the accompanying drawings which show, in a more or less conventional and diagrammatic manner, various forms of apparatus adapted for the practice of the process of the invention; but it is intended and will be understood that the invention is illustrated by, but not limited to, the specific embodiments so illustrated and described.

In the accompanying drawings

Fig. 1 is a diagrammatic illustration of one form of apparatus;

Fig. 2 is a plan view of the cracking still of Fig. 1;

Fig. 3 is a detail view of one of the insulating bushings through which the leads are introduced; and

Figs. 4 and 5 are diagrammatic views showing modified forms of apparatus.

In the apparatus of Fig. 1, the cracking still 1 is horizontally arranged and of suitable size, for example, about 9 feet long, and 3 feet in diameter, although it will be understood that the size of the still is capable of considerable variation. The cracking still has an inlet pipe 2 for the preheated oil, a valve control outlet pipe 3 for withdrawing the residue from the still, a reflux column or tower 4, and end covers or heads 5 through which access may be had to the inside of the still. Within the still are the massive carbon resistors 6, hereinafter more fully described. A pyrometer well for determining the temperature of the oil in the still is indicated at 7.

From the reflux tower 4 the distillate passes through the pipe 8, having a regulating valve therein, to the heat interchanger 9, where a part of the distillate may be condensed and withdrawn through the valve control pipe 10, the rest of the distillate passing from the valve control pipe 11 to the condensing coil 12 surrounded by water or other cooling agent. From the condensing coil the liquid condensate together with any uncondensed vapors pass through the valve controlled pipe 13 to the receptacle 14, from which the liquid can be withdrawn through the valve controlled pipe 20 and any residue deposited therein through the valve controlled pipe 19. The uncondensed vapors pass from the valve controlled pipe 15 to the receptacle 16 and thence through the valve controlled pipe 17 to the burner 18 where the uncondensed gas is burned to assist in the preheating of the oil before it enters the still.

The oil is forced by the pump 21 through the heat interchanger 9 and thence through the pipe 23 to the preheating coil 24 and thence through the pipe 2 to the still. The oil will be preheated in the heat interchanger 9 by the hot distillate passing therethrough and the oil thus preheated can be still further preheated in the coil 24 by the action of the gas burner 18. It is advantageous, as above pointed out, to preheat the oil to a temperature approximating that of the oil in the still preferably to a temperature of around 400 to 800° F., depending upon the grade of oil being cracked, so that little electrical energy will be needed in the still to raise the oil to the required temperature for the cracking operation.

It will be evident that the oil should be forced into the still, by the pump 21, at a pressure as great as that maintained within the still, which temperature, as above noted, is capable of considerable variation. In general, pressures lower than 80 pounds and higher than 300 pounds are less advantageous, and I have obtained best results at temperatures around 160 to 200 pounds.

The pressure is regulated by means of one or more of the valves in the pipes 8, 11, 13, 15 or 17. That is, the pressure may be maintained in the still by means of the valve 8, so that the subsequent condensation will take place at a lower pressure, or it may be maintained by means of the valve in the pipe 13 or the pipe 15 or the pipe 17 so that the entire condensing system will be under the same pressure as the still. The construction and arrangement is such that a part or all of the condensing system can be kept under still pressure or under lower pressures.

The vapors produced in the still under the pressure maintained therein will pass up the reflux column 4 which is exposed to the atmosphere and where any heavy material will be condensed and returned to the still. The uncondensed vapors will then go to the heat interchanger 9 yielding up part of their heat to the incoming oil and in part condensing to form a condensate which may be removed from time to time through the pipe 10 while the still uncondensed vapors pass to the condenser 12 as above described. The valve in the pipe 15, or the other valve or valves in the system which control the pressure are preferably so regulated to permit of the permanent gas to escape at the same rate that vapor is generated in the cracking still, thus maintaining the pressure in the system approximately constant.

The heating of the cracking still is effected by the action of the massive resistors 6 which are in turn heated by alternating current. These resistors are preferably of graphite or amorphous carbon, although other suitable material can be used in their construction. They are of such massive construction as to permit the necessary cleaning thereof without removal from the cracking still. The massive construction of the electrodes permits a very heavy current to be carried, for example, a current as high as 20,000 amperes or higher. The massive construction of the electrodes permits them to be self-supporting and gives them great strength and rigidity so that they can be used for long periods of time without danger of breaking even with repeated cleaning in a manner hereinafter described.

These resistors in the apparatus illustrated in Figs. 1 and 2, are three in number, and connected together at one end by the connector 25 and at the other end by means of connectors 27 with the leads 26 of

copper or other suitable metal. The connector 25, which may be a copper bar, and the copper leads 26, are so proportioned and connected that they will carry the current without danger of being heated to excessively high temperatures.

Where the resistors are of massive construction and are intended to carry a very heavy current, it is important to arrange them remote from the walls of the still, both to protect the walls of the still and to prevent short-circuiting by the growth of carbon deposit upon the resistors until it touches the still walls. If the resistors are in close proximity to the walls of the still the currents induced in the still walls will cause the walls to become very hot, with resulting heat loss and tendency toward objectionable carbon deposit on the still walls. So also, as the cracking operation progresses, carbon is deposited to a greater or less extent on the electrically heated resistors, and, if the resistors are in close proximity to the walls of the still, the growth of carbon deposit will tend to connect the resistors with the still, thus short-circuiting the heating device and causing the current to pass in part through the still walls.

The proper construction and arrangement of the resistors is accordingly of importance where heavy currents are employed, while heavy currents are themselves important to obtain proper cracking and distillation due to the heat supplied thereby. For example, the investigations that I have made indicate that with the use of currents in the neighborhood of 2,000 amperes, the distillation rate is only about 30 to 60 gallons per hour, which is too small for commercial operations unless the number of units were unreasonably multiplied. However, with a still of the construction illustrated in Fig. 1, with massive resistors carrying a current of 20,000 amperes, the cracking operation can be carried on at the rate of from 200 to 350 gallons per hour; while with apparatus of larger size containing a plurality of heating devices of a similar character either in a still of larger construction or in separate individual stills, the yield or output can be correspondingly increased.

The proper arrangement of the leads or connections for the resistors is also of importance, where heavy currents are employed, in order to avoid objectionable losses of electrical energy due to impedance and hysteresis. With alternating current, and with the heavy amperage which I employ, a very considerable percentage of the total electrical energy would be lost if the proper electrical connections were not made, for example, if the leads were introduced at opposite ends of the cracking still. However, by introducing the leads of the alternating current, whether single phase or poly-

phase, at the same location, these losses are reduced to a minimum, and the current effectively applied in the resistors themselves.

It will thus be seen, from Figs. 1 and 2, that the three leads 26 of the three-phase alternating current supplied, enter the still at the same locality and with but a small distance between them. These leads or bus-bars must, of course, be properly insulated from each other and from the walls of the still where they pass through it, and the insulation must moreover be of such a character that it will withstand the high pressures maintained in the still and prevent leakage or escape of vapors therefrom. A suitable form of insulation and stuffing box is illustrated in Fig. 3. In this figure the plate or portion of the still wall through which the leads pass is indicated at 30, and has welded thereto a tubular projection 31 externally threaded near its outer end. The copper lead 26 is closely wrapped with thin sheets of mica 32 which extend below the lower end of the extension 31 and beyond the outer end of the clamping nut 33 so that the lead is insulated by the mica both from the member 31 and the nut 33. Asbestos packing 34 is inserted in a recess in the bushing 31 and the nut 33 is then screwed down to clamp the asbestos packing 34 in place and form a tight joint, holding the mica sheets firmly against the copper lead and preventing escape of vapors from the still. With a construction and arrangement of this kind, pressures of around 200 pounds or more can readily be employed without danger of leakage around the leads and while still obtaining the necessary insulation for the heavy currents employed.

The plate 30, and also the extension 31, are advantageously made of non-ferrous metal of high resistance, such as Monel metal, in order to cut down the losses of electrical energy due to hysteresis and eddy currents, such as would result if a steel plate were used.

During the cracking operation, more or less carbon is separated from the oil and tends to deposit upon the resistors. These resistors should be spaced apart not only from the still walls but also from each other to prevent the bridging over from one resistor to the other by carbon so deposited. After a certain time, however, the carbon deposit will become so great that it may seriously interfere with the operation of the electric heating device unless it is removed. It is not feasible to take the still apart and remove the resistors for the purpose of cleaning them, inasmuch as this would involve cooling the resistors to a sufficiently low temperature to permit them to be exposed to the atmosphere, and inasmuch as the massive electrodes are not readily removed and would require a considerable

period of time before they could be safely removed. Accordingly, I provide for the cleaning of the resistors without removing them from the still. This may be effected by removing one of the heads 5, and inserting a cleaning or scraping device for scraping the deposited carbon from the resistors. This can be done without permitting the still to cool and without any considerable loss of time for the cleaning operation. It is more advantageous, however, to provide cleaning means within the still itself which can be operated periodically without opening the still. Such cleaning devices are illustrated in Figs. 4 and 5, in which corresponding parts are indicated by the same reference numerals as in Fig. 1, with the suffix "b" and "c" appended thereto.

In the construction of Fig. 4, the cleaning device consists of a series of thin sharp-edged metal bars, equally as long as the resistors and of somewhat greater height. There are two of these bars 35 for each resistor and they are all united at each end and supported by cross-bars 36 which are in turn suspended by rods 37 passing through stuffing boxes 38 and having hand-wheels or gears 39 for raising and lowering them. When excessive amounts of carbon have been deposited upon the resistors, the current is interrupted and the gears or hand-wheels 39 are turned at the same rate and in such a way that the bars 35 will be caused to rise parallel to the face of each resistor and only the fraction of an inch distance from it. The deposited carbon is thus brushed or broken from the resistors and falls to the bottom of the still. This cleaning movement can be repeated one or more times, after which the cleaning device is lowered to its original position, the current is again turned on, and the operation continued.

In the construction of Fig. 5, the cleaning device is operated by means of electro-magnets 40 having iron cores 41 secured to the lifting rods 37. The rods 37 pass through loose bearings having water-cooled devices 42 arranged to keep the heat of the still from passing to the electro-magnets, and the cores and lifting rods are suitably enclosed, as in a steel tube, to enable the pressure in the still to be maintained. When it is desired to operate the cleaning device, the heating current is interrupted, and a suitable current of electricity is caused to pass through the electro-magnets 40, the magnetic field thus produced causing the iron cores to rise and carry with them the cleaning device which will operate as above described. On interrupting the magnetizing current of the electro-magnets, the cleaning device will resume its position of rest below the resistors. The heating current is then re-established through the resistors and the process proceeds as before.

It will be evident that the provision of

cleaning devices for the resistors enables these resistors to be maintained in operation for long periods of time, with only infrequent stopping in operation for cleaning, and that such cleaning is effected without opening the still and without the necessity for cooling of the still or of the resistors.

As the cracking operation proceeds, the amount of heavy residue and suspended carbon will increase, and it will usually be desirable from time to time to withdraw the heavy sludge and suspended carbon including that broken off by the resistors. This is accomplished by opening the drawoff pipe 3, after which the pipe is closed and a fresh charge of oil introduced into the still.

In the operation of the still, the massive resistors will be maintained completely submerged in the oil, which should preferably be maintained at such a level that the still is about two-thirds full. It will be noted that the horizontal arrangement of the still gives a large surface of contact between the oil and the vapor therein, which is advantageous, and that this arrangement also provides a large vapor space within the still above the oil. The oil within the still is subjected to the heating action of the massive resistors, and is thereby heated to the cracking temperature, which will usually be between 700 and 900° F., although the particular temperature will vary with different oils. Inasmuch as the resistors themselves are completely immersed in the oil, they will be subjected to the cooling action of the oil at the same time that the oil is subjected to the heating action of the resistors. The resistors will thus be kept from attaining any undue temperatures materially in excess of that required for maintaining the oil at the proper cracking temperature and effecting the cracking and distillation at the proper rate. The oil, advantageously preheated as above described, is supplied to the still in a continuous or intermittent manner, to make up for that which has been cracked and distilled, and to maintain the proper level within the still so that the resistors will be kept submerged in the oil.

In Figs. 1 and 2 the heating is effected by three-phase alternating current supplied from the transformer 29 through the leads 26 to the three resistors 6. By using a three-phase current, each lead and each resistor will only carry a third of the total current, for example, 6666 amperes where the total of 20,000 amperes is used. This arrangement permits the use of smaller leads and distributes the current in a particularly advantageous manner. The cleaning devices, of the character illustrated in Figs. 4 and 5, are omitted from the construction of Fig. 1, but even where such cleaning devices are not provided, the massive resistors can nevertheless be cleaned by removing one of

the end plates 5 and inserting a cleaning device from outside, as above described.

A poly-phase current, such as the three-phase current illustrated in Figs. 1 and 2, or the two-phase current illustrated in Figs. 4 and 5, is particularly advantageous and is to be more particularly recommended.

A single-phase alternating current can, however, be used, although with less advantage. Where such a single-phase current is used, the leads should advantageously be introduced at the same location, the same as when a poly-phase current is used, for reasons previously stated, namely, to avoid the large losses of energy due to hysteresis and impedance which would result if the leads were introduced at opposite ends of the apparatus.

The resistors themselves may vary in size and shape, but in general they should advantageously be of a considerable height and minimum width, for example, $2\frac{1}{2}$ inches wide, 8 inches high, and 8 to 10 feet long, and with the separate resistors spaced apart a suitable distance to permit the operation of the cleaning devices and reduce the danger of bridging over therebetween by carbon deposit and resulting short-circuiting. That is, the resistors should be of massive construction and suitably arranged and spaced apart from each other and from the still walls and provided with leads of suitable construction arranged so that they enter the still at the same location. With resistors of the character described, a large heating surface is provided, and since this surface is in intimate contact with the oil it is itself cooled by the oil. The heat is thus effectively supplied to the oil, through the resistors, without objectionable overheating of either the oil or resistors.

In the practice of the process of the present invention, I recommend particularly the use of poly-phase current, such as three-phase current, which is economical and readily obtained, and the use of a heavy current of low voltage, for example, a current of 15,000 to 20,000 amperes, and 20 to 50 volts, and with massive resistors of slab-like construction, having a large heating surface in contact with the oil, and arranged to operate in the manner above described. A pressure of around 150 to 200 pounds is generally to be recommended for commercial practice, inasmuch as such pressures give greater yields of gasoline with smaller expenditure of energy per gallon of gasoline produced, while apparatus can readily be constructed capable of withstanding such pressures without danger. I also recommend such a rate of distillation that the time factor, that is, the still capacity in gallons divided by the rate of distillation in gallons per hour, be maintained around 0.8 to 1.0, since at this rate there is an approxi-

mation to the minimum expenditure of energy per gallon of gasoline produced. A more rapid rate of distillation may, however, be more advantageous where a greater number of actual gallons of gasoline per hour is more important and where the other products of the cracking operation, mainly kerosene, are of equal or greater value than the material originally treated. I also recommend that the oil be preheated in a heat exchanger and in a preheating coil to a temperature between 600 and 700° F. before it is introduced into the still so that little energy will be needed in the still to raise the oil to the required temperature.

The resistors should be proportioned to carry current enough so that the contents of the retort will distill over in from about $\frac{1}{2}$ to $1\frac{1}{2}$ hours, but for continuous operation it will be understood that the oil is supplied at substantially the rate of distillation to maintain the proper amount of oil in the still. It is also advantageous to withdraw the heavy sludge and carbon periodically and at the time of cleaning the resistors or immediately thereafter and before the current is again turned on. The carbon broken or scraped off from the resistors can thus be removed together with the heavy sludge and a fresh charge can then be introduced into the still so that the cleaned electrodes operate upon fresh oil. Such periodic cleaning and withdrawal of sludge will be more or less infrequent, depending upon the material treated and the manner of operation; but ordinarily cleaning will not be required until after the still has been in operation for several hours and with some oils the still can operate for relatively long periods of time before cleaning will be necessary.

From the foregoing description, it will be seen that the present invention provides an improved method well adapted for commercial operation, and that the invention presents various features of advantage and of novelty. The cracking operation is carried out with internal heating elements, heated by electricity, but with such size and construction of the heating elements and with such regulation of the current supplied thereto, that the oil is rapidly and effectively heated to the cracking temperature without objectionable overheating. The current supplied may thus be a heavy current, but owing to the massive character of the resistors, the heating effect of the heavy current is utilized in heating the oil, without objectionable overheating of the resistors. In fact, as above noted, the resistors have been found to have a relatively low temperature not greatly exceeding the temperature of the oil itself.

It will also be noted that the process of the present invention involves the treatment of relatively large bodies of oil within which

the resistors are submerged, as distinguished from processes involving a flow of oil past heating elements heated to an exceedingly high temperature, that is, the process of the present invention is one in which the resistors act directly upon the liquid oil and in which the oil itself is kept in intimate contact with the resistors and actually penetrates the porous surface of the carbon resistors, as distinguished from operations involving the use of such high temperatures that the oil can exist only in a vapor state at the temperatures of the heating elements or surfaces. Owing to the intimate heating effect obtained according to the present invention, the cracking operation can be effected without violent ebullition of the oil, but nevertheless with rapid and effective cracking thereof.

It is a characteristic advantage of the present invention, as hereinbefore pointed out, that the amount of permanent gas produced is very small. I have thus obtained effective cracking of the oil with the conversion of as little as 1% or less of the original oil into permanent gas. It is also a characteristic advantage of the present invention that, with increased yields of gasoline due to increased pressure, the gas loss does not correspondingly increase, but remains only a small percentage of the original oil, even where the amount of gasoline produced is as high as 35 to 40% or more of the original oil.

I do not claim herein the improved apparatus herein described, inasmuch as such apparatus forms the subject matter of a separate application.

I claim:

1. The method of cracking oils, which comprises immersing in the oil one or more massive electrical resistors, supplying poly-phase alternating current thereto to heat the oil to a cracking temperature and pressure, and regulating the current so that the temperature of the resistors does not greatly exceed that of the oil with which they are in intimate contact.

2. The method of cracking oil, which comprises immersing in a relatively large body of oil a plurality of resistors of massive construction connected with sources of poly-phase alternating current and heating the oil by means of such resistors to the cracking temperature and pressure.

3. The method of cracking oil, which comprises subjecting a relatively large body of oil to the heating action of massive resistors heated by poly-phase alternating current to the cracking temperature, maintaining the resistors submerged and in intimate contact with the oil, and supplying further amounts of oil to make up for that which is cracked and distilled.

4. The method of cracking oil, which

comprises heating the same by means of submerged electric resistors of massive construction to the cracking temperature by means of poly-phase alternating current and regulating the rate of cracking and distillation, at a pressure of about 100 to 200 pounds per square inch, so that the contents of the still will be cracked and distilled in a period from about one-half hour to one and one-half hours, and supplying further amounts of oil to make up for that which is being cracked and distilled.

5. The method of cracking oil, which comprises heating the same by means of submerged electric resistors of massive construction to the cracking temperature by means of poly-phase alternating current and regulating the rate of cracking and distillation, at a pressure of about 100 to 200 pounds per square inch, so that the contents of the still will be cracked and distilled in a period from about .8 hour to one hour.

6. The method of cracking oil, which comprises preheating the oil to a temperature below the cracking temperature, supplying the preheated oil to the cracking still and heating the same therein to a cracking temperature and pressure by means of submerged massive electric resistors heated by poly-phase alternating current, and circulating the vapors resulting from the cracking operation into heat interchanging relation with the oil entering the still, thereby preheating the oil and cooling the hot vapors.

7. The method of cracking oils, which comprises immersing in a body of the oil massive electric resistors heated by alternating current to the cracking temperature and periodically removing the carbon deposit from said resistors without removal thereof from the still.

8. The method of cracking oil, which comprises confining a relatively large body of oil in a cracking still, immersing in the oil one or more electrical resistors of massive construction, and supplying alternating current to said resistor or resistors through leads entering the still at one locality to heat the same to the cracking temperature.

9. The method of cracking oil, which comprises confining a relatively large body of oil in a cracking still, immersing in the oil electrical resistors of massive construction, and supplying a heavy poly-phase alternating current to said resistor or resistors to heat the same to the cracking temperature, the current being so regulated that the temperature of the resistor or resistors does not greatly exceed the temperature of the oil.

10. The method of cracking oil, which comprises subjecting the oil to a cracking temperature and pressure by means of submerged resistors of massive structure heated by alternating current and periodically re-

moving the carbon deposits from said resistors without cooling of the still or removal of the resistors therefrom.

11. The method of cracking oil, which comprises subjecting the oil to a cracking temperature and pressure by means of submerged resistors of massive structure heated by alternating current and periodically re-

moving the carbon deposits from said resistors without removal of the resistors therefrom and without opening the still or reducing the pressure therein. 10

In testimony whereof I affix my signature.

JOSEPH GEORGE DAVIDSON.