March 7, 1944. J. M. BARRON 2,343,848

CRACKING AND COKING HYDROCARBON OILS

Filed Dec. 31, 1940 2 Sheets-Sheet 1

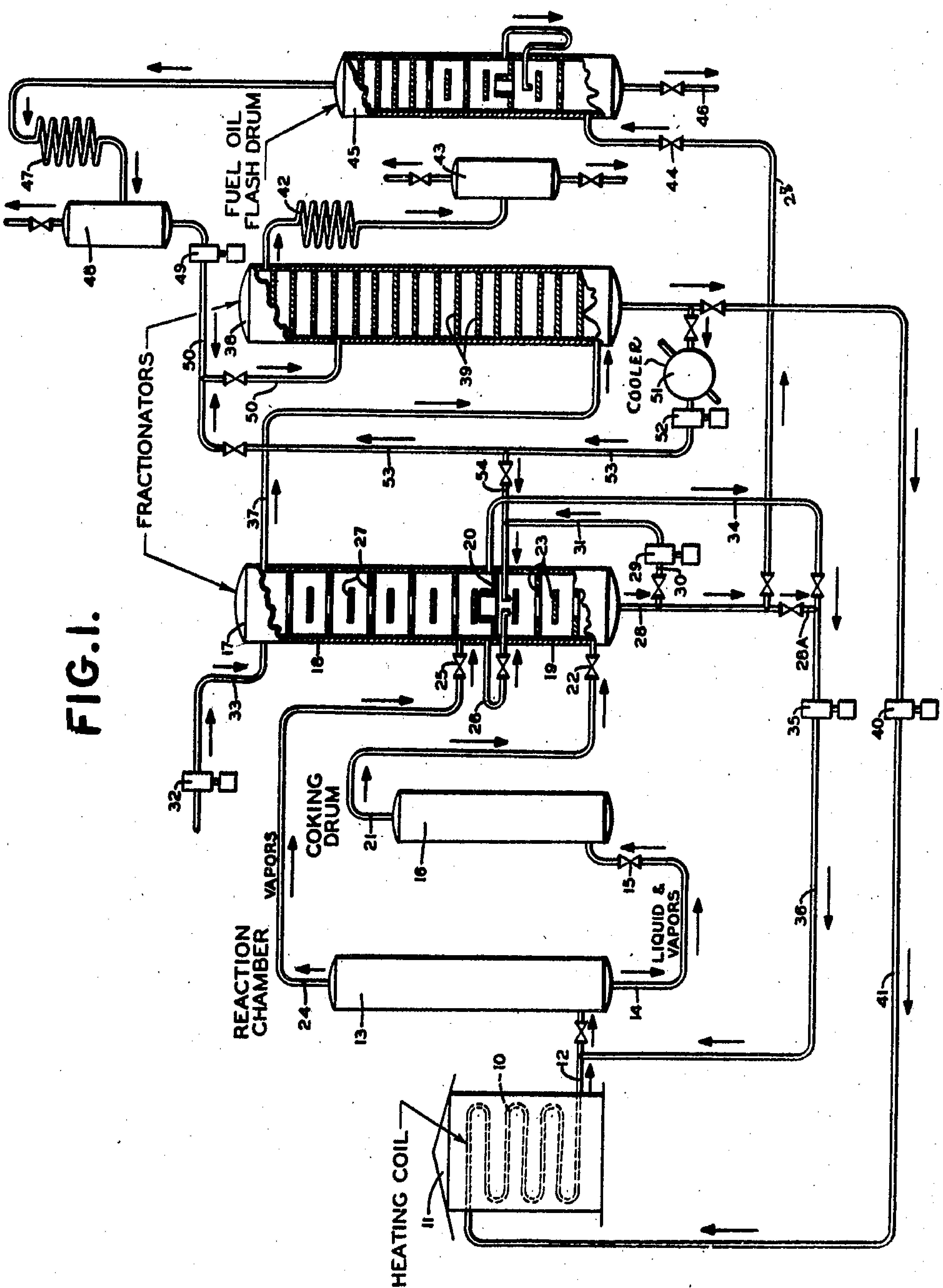

FIG. 1.

JOSEPH MASON BARRON
*INVENTOR*

*BY* Wm T. Donaldson

*HIS ATTORNEY*

March 7, 1944. **J. M. BARRON** **2,343,848**

CRACKING AND COKING HYDROCARBON OILS

Filed Dec. 31, 1940 2 Sheets-Sheet 2

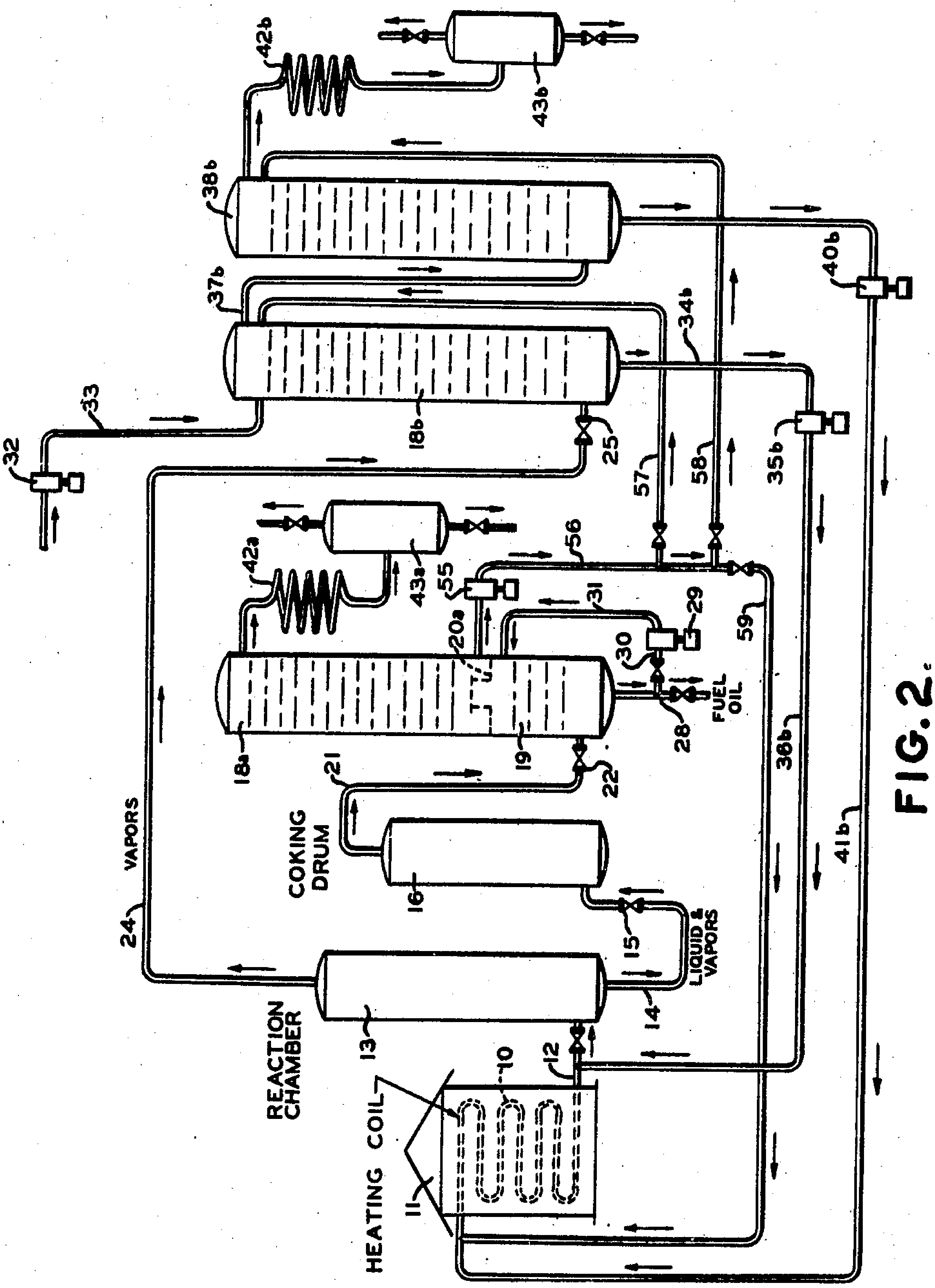

FIG. 2.

JOSEPH MASON BARRON
*INVENTOR*

*BY* Wm. Donaldson

HIS *ATTORNEY*

# UNITED STATES PATENT OFFICE

2,343,848

## CRACKING AND COKING HYDROCARBON OILS

Joseph Mason Barron, Port Arthur, Tex., assignor, by mesne assignments, to The Texas Company, New York, N. Y., a corporation of Delaware

Application December 31, 1940, Serial No. 372,451

12 Claims. (Cl. 196—48)

This invention relates to the cracking and coking of hydrocarbon oils and has particular reference to certain novel improvements in which cracked residue is reduced to coke in such a way as to avoid priming in the coking zone and in which the vapors evolved in the coking operation are dephlegmated and fractionated under conditions to avoid coking in the dephlegmating and fractionating portions of the system.

The invention contemplates a process in which hydrocarbon oil is heated to a cracking temperature and directed into a reaction zone wherein the oil is subjected to cracking conditions of temperature and pressure and wherein separation of vapors from liquid residue takes place, in which the liquid residue together with a portion of the vapors sufficient to effect coking is flash distilled to a coke residue while the remaining vapors are separately withdrawn from the reaction zone and directed to the dephlegmating portion of the system and in which the vapors evolved from the coking zone are dephlegmated under conditions in which heavy or tarry condensate separated out from the coke still vapors is cycled to the dephlegmating zone to increase the liquid movement therein and inhibit the formation or deposition of coke.

The invention has particular reference to that type of pressure cracking and coking process in which a cycle condensate is passed through a heating coil wherein it is heated to a cracking temperature, the resultant heated stream combined with a heavy stock such as topped or reduced crude and conversion of the commingled products carried on in a reaction zone and in which the residual products from the cracking operation are passed to a coking zone for conversion to coke. It has been found that when the total products from the reaction chamber, that is, all of the liquid and vaporous constituents, are delivered to the coking drum that conversion to a coke residue may be accomplished, but such operation necessitates the maintenance of relatively low charging and recycling rates in order to avoid priming in the coking drum. When an operation is carried on in which separation of vapors from liquid residue takes place in the cracking reaction chamber and when only the residue is passed to the coking chamber the autogenous heat of the residue is insufficient to effect coking. Even when withdrawing the products from the reaction chamber at a temperature as high as 910° F. it has been found that the contained heat of the residue is insufficient to effect coking for the production of marketable coke. To overcome the heat deficiency in the residue resort has been had to the by-passing of a portion of the heated stream from the condensate heating coil around the reaction chamber and into the coking drum but this operation is disadvantageous because of the resultant reduction in the quantity of the heated stream for combining with the heavy stock or black oil which has necessitated that such heavy stock or black oil be passed to a heating coil before being combined with the cycle condensate stream.

In accordance with my invention a portion of the vapors is withdrawn with the residue from the reaction chamber in quantity sufficient to effect coking but without priming in the coking drum and the vapors from the coking operation are dephlegmated in the presence of a continuous stream of liquid produced by cycling heavy condensate through the dephlegmating zone. By accomplishing the coking operation with the inclusion of a portion of the vapors in the residue passed to the coking drum it is possible to materially increase the recycling rate, that is, the rate of cycle condensate passed to the heating zone, while still avoiding priming in the coking drum. The result is that there is a greatly increased volume of high temperature vapors entering the dephlegmating portion of the system, but coking therein is effectually prevented in accordance with the invention by materially increasing the quantity and rate of liquid flow through the zone wherein the vapors from the coking operation are primarily dephlegmated. This increase in liquid flow through the primary dephlegmating zone is accomplished without any corresponding increase in cooling applied thereto. While sufficient cooling is applied to effect the desired condensation, a rate and volume of liquid flow through this primary dephlegmating zone is maintained so as to prevent coking, while still enabling the delivery of the uncondensed vapors from the primary dephlegmating zone at ample temperature to effect the desired subsequent distillation and fractionation.

More specifically the invention contemplates a process in which cycle condensate is passed through a heating zone wherein it is heated to a cracking temperature, the resultant heated products combined with oil for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, liquid residue together with a portion of the vapors withdrawn from the reaction zone and the mixture passed to a coking zone wherein autogenous coking takes place. The remaining vapors are separately withdrawn from the reaction zone and these vapors as well as the vapors from the coking zone are passed to a dephlegmating or fractionating zone. In a preferred embodiment of the invention the vapors from the coking zone are directed to a primary dephlegmating zone wherein a tarry condensate is separated from the vapors. This tarry condensate is withdrawn from the primary dephlegmating zone and a portion thereof is cycled back thereto to increase the liquid flow therein and inhibit formation or deposition of coke, while the remaining portion of the tarry condensate is withdrawn as a distillate fuel oil product. The vapors from this primary dephlegmating zone are passed to a secondary dephlegmating zone into which also the separated vapors from the reaction zone are introduced and wherein the vapors are dephlegmated with charging stock such as topped or reduced crude petroleum. The resultant mixture of condensate and unvaporized charging stock is withdrawn from the secondary dephlegmating zone and utilized as the oil being combined with the heated products from the cycle condensate heating zone. The vapors from the secondary dephlegmating zone are further fractionated to separate a reflux condensate from lighter products such as gasoline and this reflux condensate constitutes the cycle condensate which is passed to the heating zone.

Instead of withdrawing the tarry condensate as a fuel oil product of the process the vapors from the coking zone and the separated vapors from the reaction zone may be dephlegmated with the charging stock and a resultant mixture of condensate and unvaporized charging stock combined with the heated products from the cycle condensate heating zone for reaction in the reaction zone.

The invention, furthermore, contemplates the flashing of the heavy or tarry condensate produced in the primary dephlegmating zone to form a final fuel oil product of desired gravity or flash test and the refluxing of the flashed distillate in the fractionators or dephlegmators in which the vapors from the coking operation and pressure cracking operation are fractionated.

For the purpose of more fully explaining the invention reference is now had to the accompanying drawings wherein Fig. 1 is a diagrammatic sectional elevation of an apparatus adapted for the practice of the invention and Fig. 2 is a modification of the invention.

In practicing the invention cycle condensate from a source hereinafter explained is heated to a cracking temperature in a heating coil **10** mounted in a suitable furnace **11**, and the heated products pass through a transfer line **12** to a reaction chamber **13** which is suitably heat insulated and wherein separation of vapors from liquid residue takes place. Liquid is prevented from accumulating in the reaction chamber **13** by the rapid withdrawal of all the liquid together with a portion of the vapors. The mixture is passed through line **14** and pressure reducing valve **15**, thence to coking chamber **16** wherein the residue is converted to coke by means of its contained heat. In practice a plurality of coke drums are employed so that while one is on stream the other or others may be down for cleaning and thus continuous operation as regards the complete process is maintained.

The fractionating portion of the system includes a dephlegmator or fractionator **17** provided with an upper section **18** and a lower section **19** separated by a trap-out tray **20**. Vapors from the coking drum **16** pass through a line **21**, in which may be positioned a valve **22**, to the primary dephlegmating section **19** which is conveniently supplied with baffles or disc and doughnut elements **23**. The separated vapors from the reaction chamber **13** pass through a line **24** and pressure reducing valve **25** to the dephlegmating section **18** which is suitably equipped with disc and doughnut trays **27**. A valved runback line **26** may be provided for conducting liquid from the trapout tray **20** to the dephlegmating section **19** for refluxing therein.

Bottoms from the primary dephlegmator **19** are withdrawn through a line **28** and a circulating pump **29**, having its intake line **30** communicating with the line **28** and its discharge line **31** extending to the upper portion of the dephlegmator **19**, is provided for continuously circulating a portion of the bottoms through the dephlegmator. By insulating the pump and circulating lines it is possible to circulate this liquid without any substantial cooling and it is preferable to carry on the circulation without any material cooling so that the increased flow of liquid over the baffles **23** is not accompanied with cooling corresponding to the increased flow. For accomplishing the cooling which may be desirable it is preferable to employ separate refluxing means which is described hereinafter.

Charging stock is introduced by a pump **32** through a line **33** to the fractionating section **18** being preferably admitted to an upper portion thereof. The charging stock serves to dephlegmate the vapors in dephlegmator **18** and the resultant commingled reflux condensate and unvaporized charge is withdrawn from tray **20** through a line **34** and is directed by a pump **35** through a line **36** to the transfer line **12** or to the reaction chamber **13**. When running to coke and distillate fuel oil the valve in run-back line **26** is closed and all the liquid collecting on tray **20** may be directed by the pump **35** to the heater transfer line **12** or reaction chamber **13**, while the fuel oil may be withdrawn through the line **28** and a portion of the tarry condensate continuously cycled back to the dephlegmator **19** to wash the baffles therein. When running to coke only the valve in run-back line **26** is open so that the mixture of reflux condensate and unvaporized charging stock may flow into section **19** to dephlegmate the vapors therein and form a final mixture of reflux condensate and unvaporized charging stock which is passed through line **28** and a by-pass line **28–A** to line **34** thence through pump **35** and line **36** to the heater transfer line **12** or reaction chamber **13**. In the coke only operation the trapout tray **20** is unnecessary but in such operation it is desirable to introduce the vapors from the coking drum to a lower portion of the tower **17** and subject the vapors to dephlegmation and then combine the dephlegmated vapors with the vapors from the reaction chamber **13** for dephlegmation. A portion of the mixture of heavy condensate and unvaporized charging stock is continuously cycled back to the dephlegmator **19** to wash the baffles therein.

Uncondensed vapors from the tower **17** pass through a vapor line **37** to a fractionating tower **38** which is conveniently equipped with bubble trays **39** and which may be supplied with conventional cooling or refluxing means not shown. Reflux condensate is drawn from the tower **38** by a pump **40** and directed through a line **41** to the heating coil **10**. The uncondensed vapors pass from the tower **38** to a condenser **42** which discharges into a distillate receiver or gas separator **43** wherein the distillate product is collected.

The line **28** is shown provided with a pressure reducing valve **44** and extending to a flash still **45** wherein the heavy tarry distillate is flash distilled to produce a residue of desired gravity or flash test. The resultant residue is withdrawn through a line **46** and the separated vapors are subjected to such fractionation or dephlegmation as may be desired in the upper sections of the tower **45**. The overhead vapors pass to a condenser **47** and the flash distillate is collected in a receiving drum **48**. This distillate may be directed by a pump **49** through a line **50** to the fractionator **38** as a reflux therefor. Additional cooling may be supplied to the tower **38** by conducting a portion of the reflux condensate from the tower through a cooler **51** and thence by a pump **52** and line **53** to the line **50**. The line **53** may be provided with a branch line **54** extending to the upper portion of dephlegmator **19**, or to the line **31**, for supplying a cooling reflux to the dephlegmator **19**.

In the drawings the cracking chamber **13** is shown as an up-flow chamber, although a down-flow chamber may also be employed in the practice of the invention. In the down-flow operation the products from transfer line **12** including the black oil from line **36** may be introduced at the top of the reaction chamber and flow downwardly therein, the mixture of liquid residue and vapors being withdrawn from the bottom of the chamber while the separate stream of vapors is withdrawn from a lower intermediate portion of the chamber above the point of residue withdrawal. While the down-flow operation has an advantage in providing good contact between the constituents from the heating coil **10** and the black oil stream there is a tendency for the separate vapor stream to contain quantities of entrained tarry material. In another method of operation contemplated the products from transfer line **12** including the constituents from line **36** are admitted into a downflow reaction chamber in which liquid is prevented from accumulating and the products from which pass to a succeeding upflow chamber, the separate stream of vapors being taken off from the top of the upflow chamber to the fractionator and the mixture of liquid residue and vapors being withdrawn from the bottom of the upflow reaction chamber and passed to the coking drum **16**. When operating with the upflow chamber, as illustrated, it is advantageous to spray the wall of the chamber with a portion of the reflux condensate from the tower **38**.

In practicing the invention the superclean cycle condensate from fractionator **38** is subjected to cracking at temperatures of the order of 1,000 to 1050° F. preferably under reasonably high pressures such as 400–800 lbs. in the heating coil **10** and upon being commingled with the black oil stream is subjected to cracking in the reaction chamber at temperatures in excess of 900° F. under superatmospheric pressures such as 300–600 lbs. Liquid is prevented from accumulating in the reaction chamber, the mixture of liquid and vapors being rapidly withdrawn and passed to the coking chamber while the separate vapor stream is passed to the fractionating portion of the system. A temperature approximating 910° F. is recommended for the mixture of vapors and residue in the line **14**, with the temperature in the reaction chamber **13** being somewhat higher. Although the pressure is reduced in the coking drum it is recommended that superatmospheric pressures of approximately 100 lbs. or higher be maintained therein; with pressures of 350 to 400 lbs. in the reaction chamber pressures of about 150–175 lbs. are very satisfactory in the coking drum. The major portion of the vapors from the reaction chamber flows through the vapor line while only a minimum proportion of the vapors is needed for admixture with the residue to accomplish the coking thereof. The quantity of vapors required to be included in the residue being withdrawn to accomplish coking is dependent upon the temperature in the reaction chamber and it is desirable to maintain as high a temperature as possible in the reaction chamber to keep the quantity of vapor withdrawn with the residue at a minimum. Ordinarily a quantity of vapor of the order of 10%–20% of the quantity of vapors flowing from the reaction chamber will be found adequate to accomplish coking without priming. The amount required can readily be controlled by observing the temperature in the transfer line to the coking drum or in the coking drum itself. The temperature required for coking will vary with the pressure used in the coking operation and somewhat with the character of the stock. The temperature will generally be in excess of 825° F. and normally will be approximately within a range of about 840° F. to 885° F. A temperature of 850° F. under 150–175 lbs. pressure has been found very satisfactory. Under the conditions outlined coking is readily accomplished to yield a marketable coke while avoiding priming from the coke drum. The pressure in the dephlegmator or fractionator **17** will be approximately the same as that in the coke drum or if desired somewhat lower. When running to coke only, that is, when passing the mixture of heavy reflux condensate and unvaporized charging stock from dephlegmator **19** to the reaction chamber, it is desirable to maintain a temperature in the bottom of the dephlegmating section **19** as high as practicable without coking therein. Temperatures as high as 810–820° F. in the bottom of dephlegmator **19** have been successfully employed. When running to coke and fuel oil; i. e., when withdrawing from the system the bottoms from dephlegmator **19** and directing the liquid from tray **20** to the reaction chamber it is generally necessary to maintain somewhat lower temperatures in section **19**, such as 790° F.–800° F.

A portion of the bottoms from dephlegmator **19** is continuously cycled by the pump **29** over the baffles **23** therein to maintain a liquid flow therein which prevents deposition of coke. The circulation is so conducted as to keep the circulating lines open and hot and provide sufficient flow in the dephlegmator to prevent coking. The necessary cooling may be supplied by refluxing a relatively small quantity of cooled distillate through line **54**. The rate of flow and volume of hot liquid circulated to the dephlegmator is entirely out of proportion to the amount of cooling supplied. The rate of circulation of the bottoms from dephlegmator **19** is of the order of 10–25 times the rate of cooling oil supplied. When running to coke and distillate fuel oil, that is, when drawing off tarry condensate from dephlegmator **19** and withdrawing the mixture of reflux condensate and unvaporized charging stock from tray **20** for passage to the reaction chamber, the rate of the hot recycle wash will ordinarily exceed the raw oil charging rate as, for example 200-240 barrels per hour hot wash with charging rates of about 160-190 bbls. per hour, and the hot wash rate will ordinarily be of the order of one half the recycle rate to the heating coil. When running to coke only, that is, when directing the mixture of reflux condensate and unvaporized charging stock from dephlegmator **19** to the reaction chamber, the rate of the hot wash will ordinarily be somewhat less than the charging rate, as for example, 90-110 bbls. per hour hot wash with charging rates of about 125-150 bbls. per hour, and will be of the order of one-fourth or one-fifth the recycle rate to the heating coil.

The charging stock, which is most advantageously a topped or reduced crude, after such preheating as may be desired, is introduced into the dephlegmating section **18** to dephlegmate the vapors flowing upwardly therein. Gas oil constituents contained in the crude are distilled over into the tower **38**. The unvaporized residual constituents together with the reflux condensate formed in section **18** is collected in tray **20** at temperatures of the order of 800° F.-815° F. for cycling to the reaction chamber for cracking therein. The practice of the invention is particularly adapted for the treatment of crude stocks containing maximum quantities of gas oil. For the lighter stocks containing large proportions of gas oil such for example as 26-28 A. P. I. gravity topped crudes pressures approximating 400 lbs. are recommended for the reaction chamber while with heavier stocks such as a 20 A. P. I. gravity reduced crude the pressure should preferably be lowered to about 200 lbs.

The vapors pass overhead from the tower **17** at temperatures approximating 710° F.-730° F. to the tower **38** which may be maintained at approximately the same pressure as that of the tower **17**, although somewhat lower pressures may be satisfactorily employed; thus, for example, with a pressure of 150 lbs. in the tower **17** the tower **38** may be held under a pressure of 135 lbs. The temperature in the bottom of the tower **38** approximates 660° F.-680° F. The top temperature in the tower is controlled to take off the distillate of the end point desired; thus, a temperature of 390° F. under 135 lbs. pressure may be employed in taking off a 400 end point gasoline distillate.

Prior to applicant's invention it had not been possible to operate to coke and distillate fuel oil simultaneously without having to heat the black oil in a separate furnace coil. The practice of the invention has made it possible to run to coke and distillate fuel oil simultaneously with charging rates of the order of 180-200 barrels per hour. The practice of the invention has made it possible when running to coke only to raise the charging rate from about 80 barrels per hour up to 125 barrels per hour, effecting an increase in capacity of 55% without any reduction in gasoline yield, and in fact, on some units the invention has made it possible to increase the charging rate to 140 barrels per hour, effecting an increase of 75% in capacity, also without reduction in gasoline yield.

In accordance with the invention, it is possible to include sufficient vapor with the residue withdrawn from the reaction chamber to furnish sufficient heat for coking and yet have the total coking drum input well below the priming point even at capacities of 200% or more over the previous capacity. Previously, for example, when operating on topped paraffin base crude at recycle rates, that is, the rates of cycle condensate passed to the heating coil, above about 280 barrels per hour priming occurred in the coke drum which limited the charging rate to about 85 barrels per hour. Prior to applicant's invention the limits on the recycling rate, that is, the rate of cycle condensate passed to the heating coil were found to be with various stocks approximately within the range of 230 or 280 barrels per hour. The practice of the invention enables the increasing of the recycle rate up to high rates approximating 400-500 barrels per hour. In view of the high recycle rate the invention is particularly adapted for the processing of light topped crudes containing large proportions of gas oil.

The following table presents pertinent data concerning three typical runs in accordance with the invention operating on a paraffin base reduced crude charging stock:

| | Coke only, run A | Coke and dist., run B | Fuel oil, run C |
|---|---|---|---|
| Charge gravity | 26.2 | 26.2 | 25.6 |
| Charge rate ……barrels per hour | 124 | 166 | 192 |
| Recycle rate to heating coil ……do | 446 | 479 | 477 |
| Heating coil outlet temp ……°F | 1,010 | 1,015 | 1,035 |
| Reaction chamber pressure pounds per square inch | 400 | 400 | 400 |
| Temp. mixt. of vapors and res. from reaction chamber ……°F | 909 | 910 | 909 |
| Coke drum press. pounds per square inch | 175 | 175 | 155 |
| Coke drum temp ……°F | 845 | 843 | 842 |
| Black oil recycle rate to reaction chamber ……barrels per hour | 210 | 235 | 280 |
| Hot wash recycle rate ……do | 110 | 200 | 240 |

In these typical examples of the invention a yield of about 55%-60% of gasoline having an octane value of 74-77 C. F. R. R. was obtained and in runs B and C a yield of about 15% of distillate fuel oil was produced. In runs A and B the operation was with a down-flow reaction chamber and in run C the operation was with an up-flow reaction chamber. The quantity of cycle condensate cooling stock introduced to the primary dephlegmator approximated 5-15 barrels per hour.

In the modification of the invention shown in Fig. 2 the vapors from the reaction chamber and the coking drum are fractionated in entirely separate fractionating zones. In accordance with this modification the vapors from the reaction chamber **13** are passed to a primary fractionator **18b** wherein the vapors are dephlegmated with charging stock introduced by pump **32** through line **33**, the resultant mixture of reflux condensate and unvaporized charging stock is withdrawn from the fractionator **18b** through line **34b** and is directed by pump **35b** through line **36b** to the transfer line **12** to thus combine the mixture with the cycle condensate stream from the heating coil **10** for cracking in the reaction chamber **13** and the vapors from the primary fractionator **18b** are subjected to further fractionation in fractionator **38b** to separate lighter products from a reflux condensate which is cycled to the heating coil **10** by pump **40b** through line **41b**. The residue from the reaction chamber together with a portion of the vapors sufficient to effect coking is directed to the coking drum **16**. The vapors from the coking drum are directed to the separate dephlegmating zone **19** in which the tarry condensate is condensed out and a portion thereof cycled through the dephlegmating zone to increase the liquid flow and prevent deposition of carbon therein in the manner that has been explained, and the vapors uncondensed in this dephlegmating zone are subjected to further condensation or fractionation in fractionating zone **18a** to obtain a condensate which may be collected in tray **20a**, while overhead vapors are condensed in condenser **42a** and the distillate is collected in receiver **43a**. Condensate from tray **20a** is directed by a pump **55** through a line **56** having branches **57** and **58** leading, respectively, to the towers **18b** and **38b** and another branch **59** leading to the heating coil **10**, so that the condensate may be refluxed in the primary or secondary fractionating zones for the reaction chamber vapors or passed directly to the heating zone, while tarry condensate is withdrawn from the flash dephlegmating zone through line **28** as a distillate fuel oil product. This method of operation facilitates the carrying on of the coking operation at relatively low pressures while maintaining higher pressures in the reaction chamber fractionating zones. The method has the advantage that the yield of distillate fuel oil can be controlled entirely independently of the conditions obtaining in the higher pressure fractionators. The latter fractionators may, for example, be maintained at pressures such as 200 to 250 lbs. or higher while the coking operation may be conducted at pressures approximating atmospheric or at moderate superatmospheric pressures such as around 100 to 150 lbs. The modified operation increases flexibility in varying the yields of coke and distillate fuel oil to meet the market demands. In the high pressure coking operation the yield of coke cannot ordinarily be reduced below about 8% while the modified operation will permit a reduction in coke yield down to about 2%, with a corresponding increase in distillate fuel oil, as well as an increase in gasoline yield.

Although a preferred embodiment of the invention has been described herein, it will be understood that various changes and modifications may be made therein, while securing to a greater or less extent some or all of the benefits of the invention, without departing from the spirit and scope thereof.

I claim:

1. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises combining residual stock and cycle condensate stock at cracking temperature for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, passing the evolved vapors from the coking zone to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from said dephlegmating zone and cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and prevent coking, subjecting vapors uncondensed in said dephlegmating zone to further fractionation to separate a higher boiling condensate from lower boiling products, heating said higher boiling condensate to a cracking temperature and utilizing it as the aforesaid cycle condensate stock which is combined with said residual stock for cracking, separately withdrawing separated vapors from said reaction zone and subjecting them to fractionation to recover a desired product.

2. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises heating a residual stock and a condensate stock in separate heating zones and combining the heated stocks at a cracking temperature for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, passing the evolved vapors from the coking zone to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from said dephlegmating zone and cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and prevent coking, subjecting vapors uncondensed in said dephlegmating zone to further fractionation to separate a higher boiling condensate from lower boiling products, cycling said higher boiling condensate to the aforesaid heating zone in which the condensate stock is heated, separately withdrawing separated vapors from said reaction zone and subjecting them to fractionation to recover a desired product.

3. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises combining residual stock and cycle condensate stock at cracking temperature for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, delivering the liquid residue and a portion of the vapors to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so delivered to the coking zone being sufficient to effect autogenous coking of the residue, passing the evolved vapors from the coking zone to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from said dephlegmating zone and cycling a portion thereof back to the dephlgemating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and prevent coking, subjecting vapors uncondensed in said dephlegmating zone to further fractionation to separate a higher boiling condensate from lower boiling products, heating said higher boiling condensate to a cracking temperature and utilizing it as the aforesaid cycle condensate stock which is combined with said residual stock for cracking, separately withdrawing separated vapors from said reaction zone and subjecting them to fractionation to recover a desired product.

4. In the conversion of higher boiling hydro-

carbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, passing the evolved vapors from the coking zone to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from said dephlegmating zone and cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and prevent coking, subjecting vapors uncondensed in said dephlegmating zone to further fractionation to separate a higher boiling condensate from lower boiling products, separately withdrawing separated vapors from said reaction zone and subjecting them to fractionation to separate a reflux condensate from lighter products and utilizing said reflux condensate as the cycle condensate passed to the aforesaid heating zone.

5. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, delivering the evolved vapors from the coking zone to a dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein and a tarry condensate is thereby separated from the vapors, withdrawing tarry condensate from said dephlegmating zone and cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and prevent coking, passing vapors from said dephlegmating zone to a second dephlegmating zone, separately withdrawing separated vapors from the aforesaid reaction zone and delivering them to said second dephlegmating zone, introducing charging stock into said second dephlegmating zone to dephlegmate vapors therein, withdrawing a resultant mixture of condensate and unvaporized charging stock from the secondary dephlegmating zone and utilizing it as the oil being combined with the heated products from the aforesaid heating zone, subjecting vapors from the secondary dephlegmating zone to further fractionation to separate a reflux condensate from lighter products and directing said reflux condensate to the aforesaid heating zone as said cycle condensate.

6. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, delivering the evolved vapors from the coking zone to a dephlegmating zone, passing vapors from said dephlegmating zone to a second dephlegmating zone, separately withdrawing separated vapors from the aforesaid reaction zone and delivering them to said second dephlegmating zone, introducing charging stock into said second dephlegmating zone to dephlegmate vapors therein, conducting a resultant mixture of reflux condensate and unvaporized charging stock from the second dephlegmating zone to the first dephlegmating zone to dephlegmate vapors therein, withdrawing a resultant mixture of reflux condensate and unvaporized charging stock from the first dephlegmating zone, cycling a portion thereof back to the first dephlegmating zone to increase the liquid flow therein and prevent coking, utilizing the remaining portion as the oil being combined with the heated products from the aforesaid heating zone, subjecting vapors from the secondary dephlegmating zone to further fractionation to separate a reflux condensate from lighter products and directing said reflux condensate to the aforesaid heating zone as said cycle condensate.

7. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone wherein separation of vapors from liquid residue takes place, maintaining cracking conditions of temperature and pressure in the reaction zone, withdrawing the liquid residue from the reaction zone together with a portion of the vapors and delivering the mixture of vapors and liquid to a coking zone wherein conversion to a coke residue takes place, the proportion of vapors so withdrawn with the liquid residue being sufficient to effect autogenous coking of the mixture, separately withdrawing separated vapors from said reaction zone and passing said vapors to a primary pressure fractionating zone, introducing charging stock to said primary pressure fractionating zone to dephlegmate vapors therein, utilizing a resultant mixture of reflux condensate and unvaporized charging stock from said primary pressure fractionating zone as the oil combined with the heated products from the aforesaid heating zone, subjecting vapors from said primary pressure fractionating zone to further fractionation to separate a reflux condensate from lighter products and directing such reflux condensate to the aforesaid heating zone, passing the evolved vapors from the coking zone to a sep-

arate dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from said dephlegmating zone and cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to increase the liquid flow therein and inhibit deposition of coke, subjecting vapors from said dephlegmating zone to condensation to produce a condensate and combining said condensate with the aforesaid reflux condensate being directed to the aforesaid heating zone.

8. In a coking process wherein residual products from a pressure cracking operation are subjected to coking and vapors evolved in the coking operation are subjected to fractionation to obtain a condensate stock adapted for cracking into gasoline constituents, the process that comprises passing the vapors from the coking operation to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from the primary dephlegmating zone and cycling a portion thereof back thereto at a rate approximating 10–25 times the rate of said cooling fluid to thereby establish and maintain a liquid flow therein adapted to prevent coking, passing the dephlegmated vapors from said primary dephlegmating zone to a subsequent fractionating zone wherein the vapors are fractionated to separate gasoline constituents from higher boiling condensate adapted for cracking into gasoline constituents.

9. In a coking process wherein residual products from a pressure cracking operation are subjected to coking and vapors evolved in the coking operation are subjected to fractionation to obtain a condensate stock adapted for cracking into gasoline constituents, the process that comprises passing the vapors from the coking operation to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein and a tarry condensate is thereby formed, withdrawing said tarry condensate from the primary dephlegmating zone, cycling a portion thereof back to the dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to thereby establish and maintain a liquid flow therein adapted to prevent coking, withdrawing the other portion thereof from the system as a fuel oil product, passing the dephlegmated vapors from the primary dephlegmating zone to a subsequent fractionating zone wherein the vapors are fractionated to separate gasoline constituents from higher boiling condensate adapted for cracking into gasoline.

10. In a coking process wherein residual products from a pressure cracking operation are subjected to coking and vapors evolved in the coking operation are subjected to fractionation to obtain a condensate stock adapted for cracking into gasoline constituents, the process that comprises passing the vapors from the coking operation to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling oil so that temperatures of the order of 800° F. are maintained therein, withdrawing a resultant liquid product of dephlegmation from the primary dephlegmating zone and cycling a portion thereof back thereto at a rate approximating 10–25 times the rate of said cooling oil to thereby establish and maintain a liquid flow therein adapted to prevent coking, passing the dephlegmated vapors from said primary dephlegmating zone to a subsequent fractionating zone wherein the vapors are fractionated to separate gasoline constituents from higher boiling condensate adapted for cracking into gasoline constituents.

11. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone, maintaining cracking conditions of temperature and pressure in the reaction zone, expanding resultant cracked products comprising residual constituents into a coking zone wherein conversion to a coke residue takes place, passing evolved vapors from the coking zone to a primary dephlegmating zone wherein the vapors are dephlegmated with the application of a limited amount of cooling fluid so that temperatures of the order of 800° F. are maintained therein and a tarry condensate is thereby formed, withdrawing said tarry condensate from the primary dephlegmating zone, cycling a portion thereof back to said dephlegmating zone at a rate approximating 10–25 times the rate of said cooling fluid to thereby establish and maintain a liquid flow therein adapted to prevent coking, withdrawing the other portion thereof from the system as a fuel oil product, passing the dephlegmated vapors from the primary dephlegmating zone to a secondary dephlegmating zone, introducing charging stock to dephlegmate vapors therein, withdrawing a resultant mixture of reflux condensate and unvaporized charging stock and utilizing such mixture as the oil which is combined with the heated products from said heating zone as aforesaid, passing the dephlegmated vapors from the secondary dephlegmating zone to a subsequent fractionating zone wherein the vapors are fractionated to separate lighter constituents from higher boiling condensate and cycling said higher boiling condensate to the aforesaid heating zone.

12. In the conversion of higher boiling hydrocarbon oils into lower boiling ones, the process that comprises passing cycle condensate to a heating zone wherein it is heated to a cracking temperature, combining resultant heated products with oil for cracking in a reaction zone, maintaining cracking conditions of temperature and pressure in the reaction zone, separating resultant cracked products into vapors and residue in a separating zone, withdrawing products comprising residual constituents of cracking from the separating zone and delivering said products to a coking zone wherein conversion to a coke residue takes place, passing the evolved vapors from the coking zone to a primary dephlegmating zone, passing the dephlegmated vapors from said primary dephlegmating zone to a secondary dephlegmating zone, separately withdrawing separated vapors from the aforesaid separating zone and delivering them to said secondary dephlegmating zone, introducing charging stock to said secondary dephlegmating zone to dephlegmate vapors therein, conducting a resultant mixture of reflux condensate and unvaporized charging stock from the secondary dephlegmating zone to the primary dephlegmating zone, applying only a limited cooling to the primary dephlegmating

zone so as to maintain throughout said zone a temperature within the cracking range, withdrawing a resultant mixture of reflux condensate and unvaporized charging stock from the primary dephlegmating zone, cycling a portion thereof back to said primary dephlegmating zone to thereby increase the liquid flow therein and prevent coking, utilizing the remaining portion as the oil being combined with the heated products from the aforesaid heating zone, subjecting vapors from the secondary dephlegmating zone to further fractionation to separate a reflux condensate from lighter products and directing said reflux condensate to the aforesaid heating zone.

JOSEPH MASON BARRON.

# Certificate of Correction

Patent No. 2,343,848. March 7, 1944.

JOSEPH MASON BARRON

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, lines 20 to 24, inclusive, the heading of the table should appear as shown below instead of as in the patent:

| | Coke only, Run A | Coke and dist. fuel oil | |
|---|---|---|---|
| | | Run B | Run C |

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of May, A. D. 1944.

SEAL]

LESLIE FRAZER,
*Acting Commissioner of Patents.*