Our invention relates to a method of and apparatus for treating hydrocarbon oils to produce a product relatively free from carbonaceous content and, as a continuing phase of the invention, subsequent recovery of lighter components of the product through cracking out without the "coking" incident to ordinary cracking processes and methods.

One of the principal difficulties encountered in the recovery or manufacture of gasoline by cracking is accumulation of carbon or coke in the stills, towers and lines, due to separation of components of the charging stock under high heats and pressures, the principal accumulation occurring in the cracking stills to which heavier components of virgin stock are delivered after separation of the natural gasoline by skimming.

If the carbon forming components be removed prior to delivery of the stock to the cracking stills, much delay in operation ordinarily occasioned by shut-downs to clean the stills, and danger incident to operation of the stills when they are in coked condition, may be eliminated.

It is the object of our invention to remove such carbon forming content from the stock following the skimming operation but prior to delivery of the residual component commonly known as "gas oil" to the cracking still or to storage for future treatment.

This object is accomplished in accordance with our improved method, presently described, and with apparatus, a preferred form of which is illustrated in the accompanying drawings, to which reference will be made for disclosure of both phases of the invention.

In the drawings:

Fig. 1 is a diagrammatical perspective view of an apparatus embodying the features of this invention. Fig. 2 is a section showing the discharge pipe near the middle of the column.

1 designates a source of supply of crude oil, here shown to consist of an ordinary storage tank and 2 a suction line through which oil may be drawn from the supply source by a charging pump 3 under control of a valve 4 in the line 2.

Leading from the pump 3 is a line 5 comprising an internal heating coil 5' located in a fractionating tower 8 presently described, and a return 5"' opening to a receiving and distilling column represented by the bubble tower 6.

When the method is practised in its simplest form, that is, independently of the cracking phase, the oil, upon delivery to the distilling column, expands at relatively low temperature and at substantially atmospheric pressure, the natural or straight run gasoline passing off in vapors through a line 7 to the bottom of the fractionating tower 8, consisting of an ordinary bubble tower, through which the lighter ends escape to a line 9 through which they pass to a condenser 10, the condensed liquid passing from the coil to a storage tank 11. The columns, or towers, 6 and 8 constitute a reflux condenser.

Heavier fractions of the oil, remaining in the liquid phase, pass down through the upper bubble plates and are drawn off through a line 12 opening through one of the intermediate bubble plates and a surge tank 13 by a pump 14, and forced by the pump through a line 15 to a skimming still 16, where the oil absorbs sufficient heat necessary for the vaporization of the desired non-carbonaceous lighter fraction of the original oil.

The oil is flowed through the skimming still under low pressure and is heated in the still to such temperature that it separates into light and heavy fractions, which pass together from the still through a line 17 (valved at 18) to an expansion chamber 19, the light fractions entering the chamber in vapor phase and the heavier in liquid or semisolid phase.

The vapors entering the expansion chamber pass therefrom through a vapor line 20 (valved at 21), and the heavier fractions are drawn off through a line 22 (valved at 22) to a storage tank 23; desired consistency and quality of the overhead product being secured by regulation of the valve 21, and substantially all carbonaceous content passing off with the heavier fractions, so that the drawn off vapors are substantially free from carbon forming content oils and may be disposed of as waste products.
constitute "clean" stock for charging to a cracking still.

This constitutes the simple phase of the invention.

When the gas oil product from this simple phase is to be used immediately as charging stock for a cracking still, the vapor line 22 from expansion chamber 19 is connected to the initial distilling column 6 below the bubble plates, so that the lighter, clean vapors rise through the plates and through the shower of liquid dropping through the plates above the mouth of line 22, heating the liquid to promote vaporization of the showered liquid and passing off with the natural vapors to the primary condenser, heavier fractions of the clean vapors condensing and settling to the bottom of the tower to mix with condensate coming from the bottom of the fractionator 8 through line 24, and from another source presently mentioned.

The heavy fractions collected in the bottom of the distilling column 6 are drawn off in liquid form through a line 25 (valved at 26) and forced through a line 27 (valved at 28) to a cracking still or coil 29 under high pressure by a high pressure, hot oil pump 30, and forced from the still as vapors and liquids still under pressure through a line 31 to an expansion chamber 32.

Upon entering the expansion chamber 32 the vapors and liquids separate—the vapors passing off through a pressure control valve 34 to line 33 to the primary distilling column, which they enter below the bubble plates, the vapors travelling up the distilling column 6 being scrubbed by the down coming liquids from the fractionating column 8, thereby condensing the heavy fractions of said vapors. These condensed vapors constitute a portion of the internal recycling stock. The liquids in the chamber 32 are allowed to pass off in liquid form through the line 35, preferably to the bottom of the expansion chamber 19, and thence through the controlled valve 22' to the line 22 to the storage tank 23.

Upon entering the distilling column 6 the cracked vapors rise through the bubble plates, their heavier fractions being knocked back by incoming charging stock flowing counter-current to the vapors, which have combined with those entering the tower from the expansion chamber 19, as heretofore described. The lighter fractions of these combined vapors pass off to the primary condenser with the natural gasoline vapors, and the residual oil, collecting in the bottom of the tower, is drawn off through line 25, along with the condensed heavy ends of the clean vapors entering the tower from expansion chamber 19, for recycle through the cracking still.

As any carbonaceous content remaining in the oil after the preliminary treatment will collect as loose carbon in the bottom of the expansion chamber 32 upon circulation and recirculation of the stock, we prefer to employ the stepped outlets 36 and 37 opening to the lower portion of the column at different levels, so that should the column fill with coke to the level of a lower outlet, the latter may be cut off and outflow taken from the upper member. The outlets are provided with valves 38 and 39 for effecting selection for the above purpose.

It is apparent from the foregoing that with our method and apparatus constituents of the heavy, carbon-bearing part of any hydrocarbon oil, constituting residual oil from distillation of the natural gasoline in the ordinary manner, may be separated continuously into two components—one comprising a hydrocarbon oil containing practically all of the carbonaceous matter contained in the original oil, and the other a hydrocarbon oil containing little or no carbonaceous matter.

In accordance with our method, original separation of the lighter fractions of virgin stock is effected at such low temperature and pressure as to leave high and intermediate boiling point hydrocarbons as a residual in the liquid phase, which, when first subjected to heat and pressure and then escaped to low pressure, separates into high boiling point and low boiling point fractions; the high boiling point fractions containing substantially all of the carbon-forming content material, being drawn off in liquid form for use as fuel oil, and the low boiling point fractions, containing practically no carbon-forming content material, being drawn off in vaporous form as gas oil to constitute a clean cracking stock.

It is further apparent that the condensed vapors from such preliminary distillation may be passed through a cracking process with a minimum amount of coking in the coils and flow lines, thereby eliminating the disadvantages heretofore mentioned as incident to the ordinary cracking operations.

What we claim and desire to secure by Letters Patent is:

1. The method of treating hydrocarbon oils comprising distilling virgin stock in a zone of low pressure, drawing off the lighter components of said stock in vaporous form, pumping heavier components of said stock from said zone of low pressure to a second zone of low pressure in liquid form and in restricted flow to build up pressure on said liquid body prior to its escape to said second zone of low pressure, heating said body during its restricted flow to a temperature sufficient to effect vaporization of only lighter components of said body upon subsequent release of said body to the second zone of low pressure, drawing off heavier components of said body from said second zone in.
liquid form, drawing off lighter components of said body from said second zone in vaporous form, passing said last named vapors back to the first zone of low pressure, pumping condensate of said vapors from said first zone through a cracking still to a third zone of relatively high pressure, passing lighter components of the oil from said third zone to the first named zone in vaporous form and drawing off heavier components of said oil from said third zone in liquid form.

2. The method of treating hydrocarbon oils comprising distilling virgin stock in a zone of low pressure, drawing off the lighter components of said stock in vaporous form, pumping heavier components of said stock from said zone of low pressure to a second zone of low pressure in liquid form and in restricted flow to build up pressure on said liquid body prior to its escape to said second zone of low pressure, heating said body during its restricted flow to a temperature sufficient to effect vaporization of only lighter components of said body upon subsequent release of said body to the second zone of low pressure, drawing off heavier components of said body from said second zone in liquid form, drawing off lighter components of said body from said second zone in vaporous form, passing said last named vapors back to the first zone of low pressure, pumping condensate of said vapors from said first zone through a cracking still to a third zone of relative high pressure, passing lighter components of the oil from said third zone to the first named zone in vaporous form and drawing off heavier components of said oil from said third zone in liquid form, vapors from the second and third zones rising through the first zone in counter-current to incoming virgin stock.

3. Apparatus of the character described, comprising a distilling chamber, means for conducting virgin stock to said chamber, means for drawing off lighter components of said stock from said chamber in vaporous form, an expansion chamber, a line from the distilling chamber to the expansion chamber, a pump in said line for delivering heavier components of said stock from the distilling chamber to the expansion chamber in liquid form, means for heating liquid passing through said line, means for conducting heavier components from said expansion chamber in liquid form, means for conducting lighter components from said expansion chamber back to the distilling chamber in vaporous form, an expansion chamber, a line for conducting condensate from said distilling chamber to said second chamber, a cracking still in said line, a pump in said line for forcing said condensate through the line and still, means for drawing off heavier components from the second chamber in liquid form, and means for passing lighter components from said second chamber back to the distilling chamber in vaporous form.

4. Apparatus of the character described, comprising a distilling chamber, means for conducting virgin stock to said chamber, means for drawing off lighter components of said stock from said chamber in vaporous form, an expansion chamber, a line from the distilling chamber to the expansion chamber, a pump in said line for delivering heavier components of said stock from the distilling chamber in liquid form, means for heating liquid passing through said line, means for conducting heavier components from said expansion chamber in liquid form, means for conducting lighter components from said expansion chamber back to the distilling chamber in vaporous form, a second expansion chamber, a line for conducting condensate from said distilling chamber to said second chamber, a cracking still in said line, a pump in said line for forcing said condensate through the line and still, means for drawing off heavier components from the second chamber in liquid form, and means for passing lighter components from said second chamber back to the distilling chamber in vaporous form, the means for returning vapors from the expansion chambers to
the distilling chamber having connection with the distilling chamber below the points of intake of virgin stock and of return of liquid from the fractionator.

6. Apparatus of the character described, comprising a distilling chamber having bubble trays in its upper portions, means for conducting virgin stock to said chamber, means for drawing off lighter components of said stock from said chamber, in vaporous form, a fractionator for said vapors, a condenser, means for conducting lighter components from said fractionator to said condenser in vaporous form, means for returning heavier components of said vapors from the fractionator to the distilling chamber in liquid form, an expansion chamber including bubble trays, a line leading to the expansion chamber from a point in said distilling chamber, a pump in said line for delivering heavier components of virgin stock from the distilling chamber to the expansion chamber in liquid form, means for heating liquid passing through said line, means for conducting heavier components from said expansion chamber in liquid form, means for conducting lighter components from said expansion chamber back to the distilling chamber in vaporous form, a second expansion chamber, a line for conducting condensate from said distilling chamber to said second chamber, a cracking still in said line, a pump in said line for forcing said condensate through the line and still, means for drawing off heavier components from the second chamber in liquid form, means for passing lighter components from said second chamber back to the distilling chamber in vaporous form, the means for returning vapors from the expansion chambers to the distilling chamber having connection with the distilling chamber below the points of intake of virgin stock and of return of liquid from the fractionator, the means for conducting heavier components from the second chamber having connection with the first mentioned expansion chamber below the point for delivering heavier components of the distilling chamber to said first mentioned expansion chamber and below the bubble trays, a line for conducting the combination of heavier components from the first mentioned expansion chamber to storage, and a valve in said line to regulate the flow of said combination of heavier components from said first mentioned expansion chamber.

7. The method of treating hydrocarbon oils comprising distilling a stream of hydrocarbon oil in a zone of relatively low pressure, drawing off the lighter components of said stream in vaporous form, pumping heavier components of said stream from said zone of relatively low pressure to a second zone in restricted flow to build up pressure on said liquid body prior to its escape to said second zone, heating said stream during its restrict-
ed flow to a temperature sufficient to effect vaporization of lighter components of said stream upon subsequent release of said stream to the second zone, drawing off heavier components of said stream from said second zone in liquid form, drawing off lighter components of said stream from said second zone in vaporous form, passing said last named vapors back to the first mentioned zone, pumping condensate of said vapors from said first zone under a relatively high pressure through a cracking still to a third zone, passing lighter components of the oil from said third zone to the first named zone in vaporous form and drawing off heavier components of said oil from said third zone in liquid form.

8. The method of continuously skimming and cracking hydrocarbons which comprises preheating a stream of charging stock in a reflux condenser and thereby vaporizing the lightest fraction from the stream, continuing the skimming operation by forcing the unvaporized oil through a skimming still without substantially cracking the constituents of said oil, subjecting the resultant vapors to reflux condensation in said reflux condenser, forcing the reflux condensate through a cracking still under pressure so as to crack the said reflux condensate, vaporizing the cracked condensate, subjecting the cracked vapors to reflux condensation, and adding the cracked reflux condensate to reflux condensate produced in said skimming operation.

9. The method of continuously skimming and cracking hydrocarbons which comprises preheating a stream of charging stock in a reflux condenser and thereby vaporizing the lightest fraction from the stream, continuing the skimming operation at a higher temperature by forcing the unvaporized oil through a skimming still under pressure without substantially cracking the constituents of the oil, expanding the mixture passing from said skimming still to vaporize portions of the oil, at the same time removing the residual oil from the vapors, subjecting the vaporized portions to reflux condensation, forcing the reflux condensate through a cracking still under pressure so as to crack the reflux condensate, expanding the cracked mixture passing from said cracking still to vaporize portions of said cracked mixture, at the same time dropping residual oil therefrom, discharging said residual oils from the system, subjecting the cracked vapors to reflux condensation, and adding the cracked reflux condensate to the reflux condensate produced in said skimming operation.

10. The method of continuously skimming and cracking hydrocarbons which comprises preheating a stream of crude oil in a reflux condenser and thereby vaporizing the lightest fraction from the stream, continuing the
skimming operation by forcing the preheated unvaporized oil through a skimming still under pressure without substantially cracking the constituents of the stream, expanding the mixture passing from said skimming still to vaporize portions of the oil, at the same time removing the residual oil, subjecting the vaporized portions to reflux condensation, forcing the reflux condensate through a cracking still under pressure so as to crack the reflux condensate, expanding the cracked mixture passing from said cracking still to vaporize portions of said cracked mixture, at the same time removing the cracked residual oil, reducing the pressure and discharging the last mentioned residual oil into the first mentioned residual oil, removing the mixed residual oils from the system, subjecting the cracked vapors to reflux condensation, and adding the cracked reflux condensate to the reflux condensate produced in said skimming operation.

11. The method of continuously skimming and cracking hydrocarbons which comprises forcing a stream of oil through a skimming still under pressure without substantially cracking the constituents of the stream, reducing the pressure on the stream passing from said skimming still to vaporize portions of the oil, at the same time removing the residual oil, subjecting the vaporized portions to reflux condensation, forcing the reflux condensate through a cracking still under a higher pressure so as to crack the intermediate fraction resulting from the skimming operation, expanding the cracked stream passing from said cracking still to vaporize portions of said cracked stream, at the same time removing the cracked residual oil, discharging said cracked residual oil, subjecting the cracked vapors to reflux condensation, and adding the cracked reflux condensate to the reflux condensate produced in said skimming operation.

12. The method of continuously skimming and cracking hydrocarbons which comprises skimming but not substantially cracking a stream of crude oil by heating the stream under pressure to a temperature high enough to vaporize the light natural gasoline fraction in the crude oil, thereby vaporizing said gasoline fraction, removing the gasoline vapors from the unvaporized oil in said reflux condenser, condensing said light gasoline fraction in another condenser, separately removing the unvaporized oil from the reflux condenser, and continuing the skimming operation by pumping the liquid portion of the preheated oil under pressure through a skimming still at the skimming temperature required to vaporize the natural gas oil fraction of said crude oil, conducting the resultant heated mixture to an expansion chamber, depositing the carbonaceous residual oil in said chamber and maintaining the pressure therein low enough to release said gas oil and lighter fractions in the form of vapors, removing said residual oil from the system, subjecting said vapors to reflux condensation under a pressure lower than the first mentioned pressure and thereby condensing the gas oil fraction of the crude oil, cracking the condensed gas oil by pumping it through a cracking coil under a higher pressure, transmitting the cracked mixture from said coil to a chamber and maintaining the pressure therein low enough to release said gas oil and lighter fractions in the form of vapors, removing said residual oil from the system, subjecting said vapors to reflux condensation under a pressure lower than the first mentioned pressure and thereby condensing the gas oil fraction of the crude oil, cracking the condensed gas oil by pumping it through a cracking coil under a higher pressure, transmitting the cracked mixture from said coil to a vaporizing chamber and depositing the carbonaceous residuum therefrom.
sure and temperature, transmitting the cracked mixture from said cracking still to a second expansion chamber and depositing the carbonaceous residuum therein, subjecting the cracked vapors to reflux condensation, and mixing the resultant reflux condensate with gas oil condensate passing to said cracking still.

In testimony whereof we affix our signatures.

JOHN W. COAST, Jr.
GORDON T. GRANGER.
DISCLAIMER


Hereby enters this disclaimer to claims 11, 12 and 13 of the aforesaid Letters Patent which are in the following words, to wit:

"11. The method of continuously skimming and cracking hydrocarbons which comprises forcing a stream of oil through a skimming still under pressure without substantially cracking the constituents of the stream, reducing the pressure on the stream passing from said skimming still to vaporize portions of the oil, at the same time removing the residual oil, subjecting the vaporized portions to reflux condensation, forcing the reflux condensate through a cracking still under a higher pressure so as to crack the intermediate fraction resulting from the skimming operation, expanding the cracked stream passing from said cracking still to vaporize portions of said cracked stream, at the same time removing the cracked residual oil, discharging said cracked residual oil, subjecting the cracked vapors to reflux condensation, and adding the cracked reflux condensate to the reflux condensate produced in said skimming operation.

"12. The method of continuously skimming and cracking hydrocarbons which comprises skimming but not substantially cracking a stream of crude oil by heating the stream under pressure to a temperature high enough to vaporize the gas oil and lighter fractions, transmitting the resultant mixture to an expansion chamber, depositing the carbonaceous residual oil in said chamber and maintaining the pressure therein low enough to release said gas oil and lighter fractions in the form of vapors, removing said residual oil from the system, subjecting said vapors to reflux condensation under a pressure lower than the first mentioned pressure and thereby condensing the gas oil fraction of the crude oil, cracking the condensed gas oil by pumping it through a cracking coil under a higher pressure, transmitting the cracked mixture from said coil to a vaporizing chamber and depositing the carbonaceous residuum therein, removing said residuum from the system, subjecting the cracked vapors to reflux condensation, and mixing the resultant reflux condensate with said gas oil fraction of the crude oil passing to said cracking coil, so as to subject the mixture to the cracking operation.

"13. The method of continuously skimming and cracking hydrocarbons which comprises skimming but not substantially cracking a stream of crude oil by heating the stream under pressure to a temperature high enough to vaporize gas oil and lighter fractions, transmitting the resultant mixture to an expansion chamber, depositing the carbonaceous residual oil in said chamber and maintaining the pressure therein low enough to release said gas oil and lighter fractions in the form of vapors, removing said residual oil from the system, subjecting said vapors to reflux condensation under a pressure lower than the first mentioned pressure and thereby condensing the gas oil fraction of the crude oil, cracking the condensed gas oil by pumping it through a cracking coil under a higher pressure, transmitting the cracked mixture from said coil to a chamber and separating the vapors from the carbonaceous residuum therein, removing said residuum from the system, subjecting the cracked vapors to reflux condensation, and mixing the resultant reflux condensate with said gas oil fraction of the crude oil passing to said cracking coil, so as to subject the mixture to the cracking operation, and transmitting heat from said cracked vapors to said stream of crude oil before said stream is heated to vaporize the gas oil."

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