

June 9, 1931.

E. C. HERTHEL

1,809,273

OPERATION OF PRESSURE STILLS

Filed Nov. 21, 1924

3 Sheets-Sheet 1

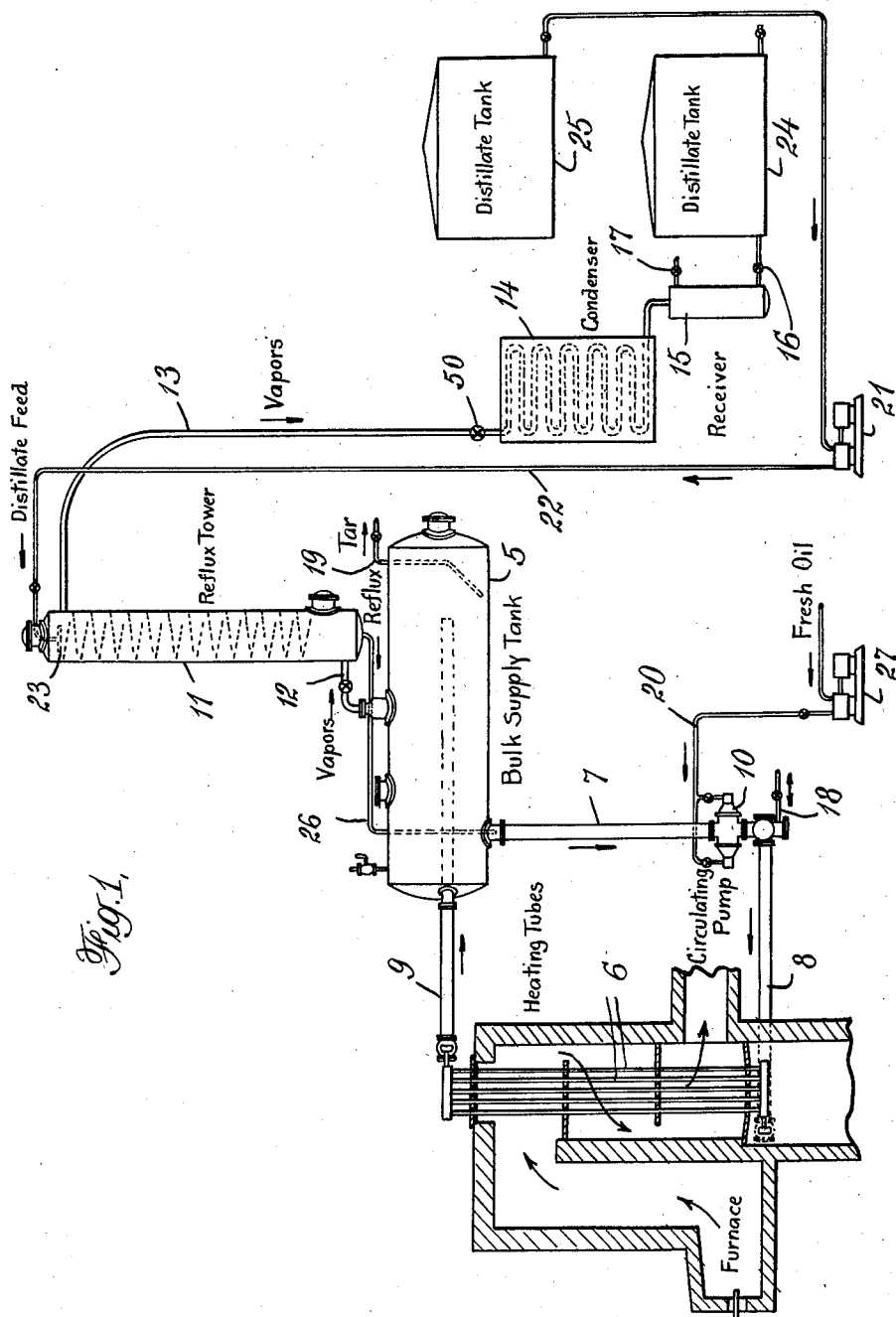


Fig. 1.

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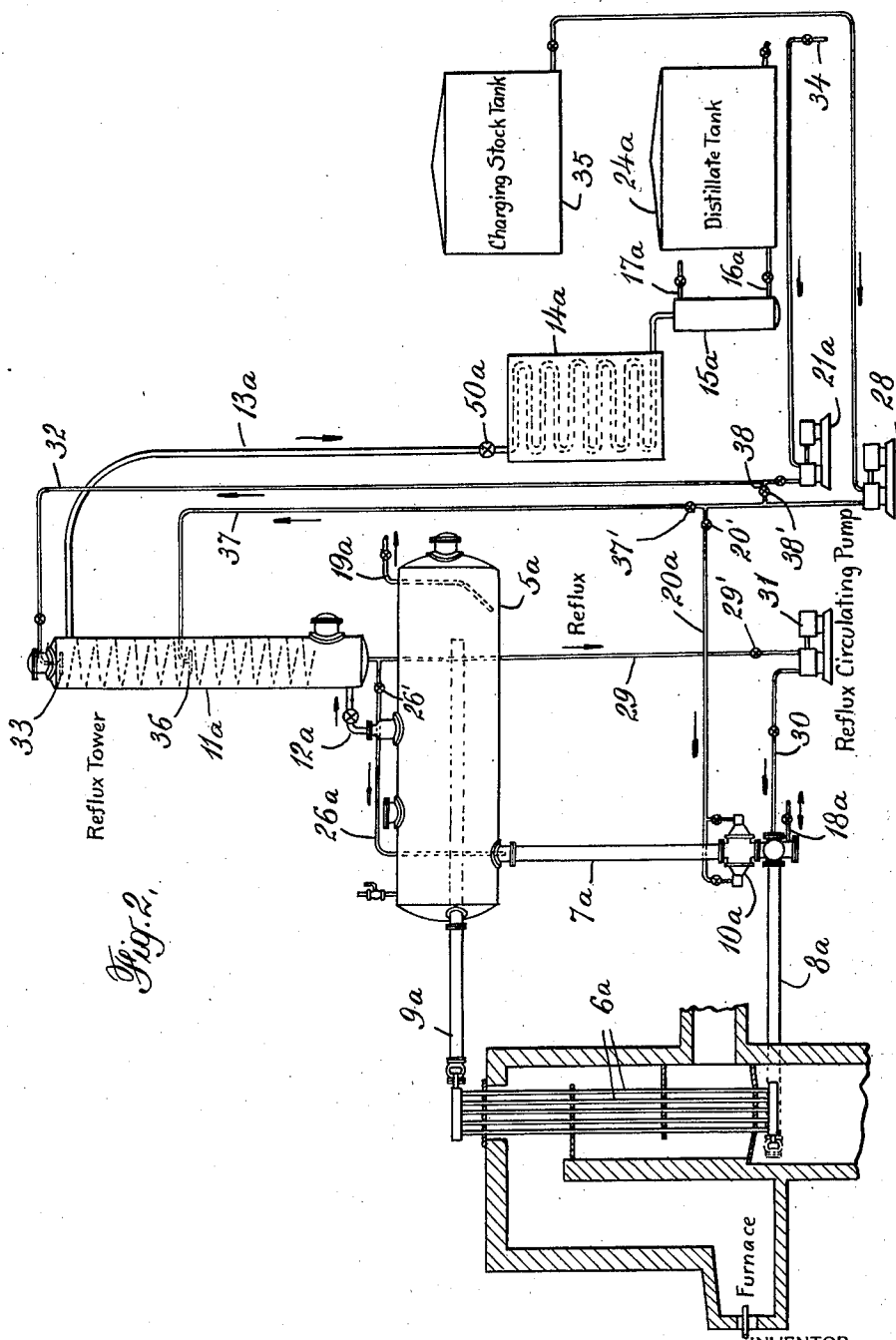
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

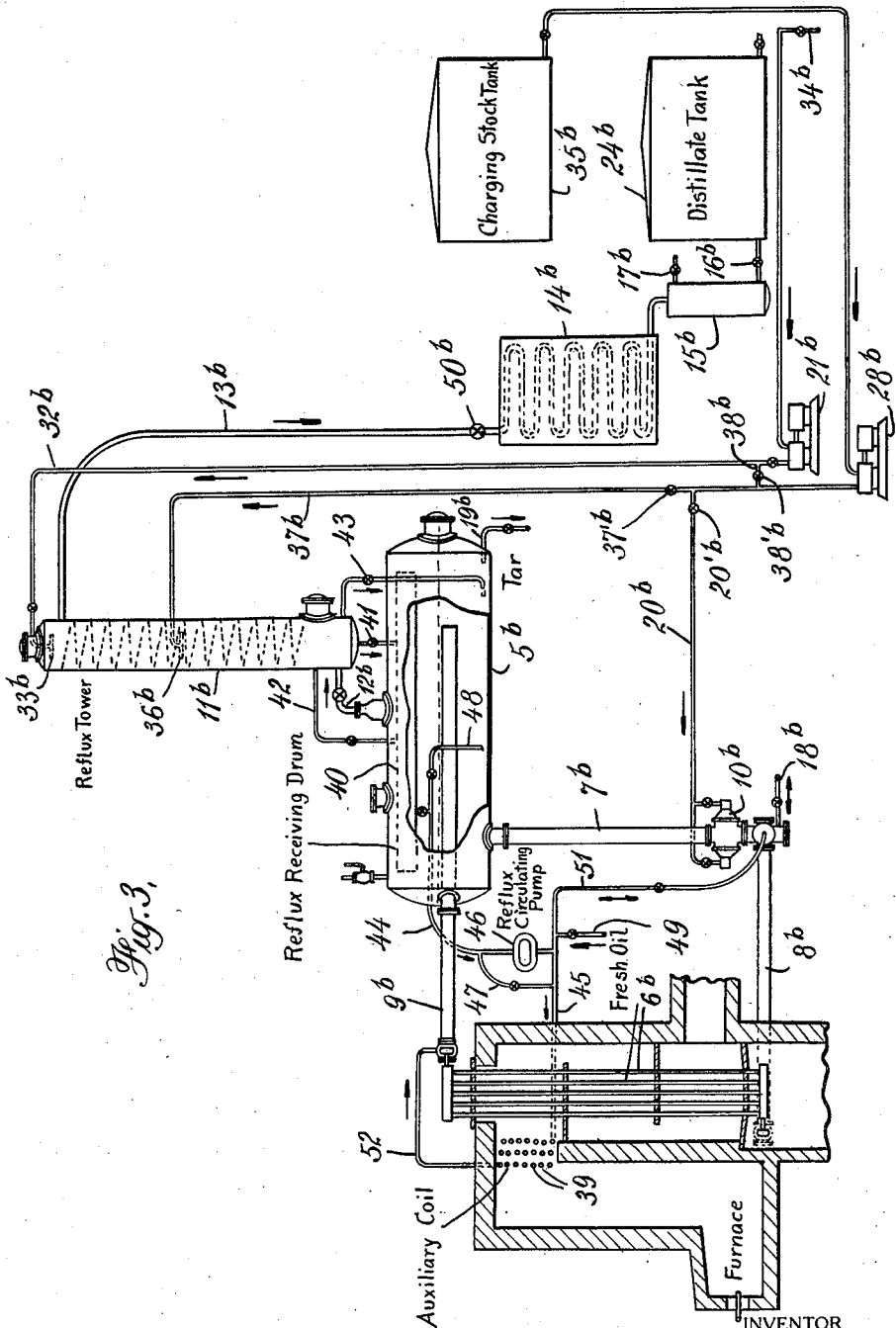


Fig. 3.

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OPERATION OF PRESSURE STILLS

Application filed November 21, 1924. Serial No. 751,213.

This invention relates to improvements in the cracking of heavier hydrocarbon oils, such as gas oil, for the production of lighter hydrocarbon oils, such as gasoline and pressure distillate, therefrom. The invention includes improvements in the operation of pressure cracking stills, particularly circulatory pressure stills, and improvements in the operation of reflux towers employed in conjunction with pressure cracking stills.

When heavy hydrocarbons are distilled under pressure, they are "cracked" with the production of lighter oils. The products of the cracking reaction also include incondensable gases, and carbon or coke, or heavy tar. In the commercial operation of a pressure still, some definite product or group of products, for example gasoline or pressure distillate, is usually desired but the vapors escaping from the still itself may include heavier constituents in addition to the constituents desired in the pressure distillate; and, in some cases, particularly in the distillation of lighter charging stocks, the escaping vapors may include vaporized constituents from the charging stock in their original condition. The vapors from the pressure still are commonly subjected to a refluxing operation to effect, to a greater or less extent, the return of such heavier vaporized constituents to the still for further treatment therein, but, as ordinarily practiced, such methods have nevertheless resulted in the production of distillates containing large amounts of constituents heavier than the desired pressure distillate. For example, in treating gas oil for the production of gasoline by such methods, the pressure distillate usually includes a considerable amount of constituents of a kerosene character and others even heavier, so that it has been necessary to subject a relatively large amount of distillate to redistillation to fractionate it into merchantable products and to separate the heavier components. Where refining methods involving chemical treatment followed by redistillation have been applied to such distillates, this has resulted in the chemical treatment of an amount of oil materially larger than that obtained as merchantable products.

According to the present invention, the pressure distillation is carried out to produce a more concentrated distillate of the desired character containing an increased amount of components suitable in the desired products and a decreased amount of heavier constituents.

According to the present invention, a fraction including constituents of a character corresponding to the condensed pressure distillate, is employed for promoting and controlling in an improved manner a refluxing operation to which the vapors from the pressure still are subjected and for returning to the body of oil in the pressure still the heavier constituents of the vapors unsuitable as components of the desired pressure distillate with resulting improvement in the operation of the pressure still itself.

When a charge of oil, such as gas oil, is subjected to a cracking temperature in a pressure still, cracking takes place in a gradual and progressive manner. Lighter constituents produced by the cracking operation are vaporized, and other constituents, such as heavier hydrocarbons formed by the cracking operation, may remain and mix with the charge in the still. A small amount of asphaltic or pitch like constituents is also progressively formed. During the early part of the operation, these pitch-like constituents may remain more or less completely in solution in the charge, but with gradual and progressive cracking the amount of such constituents gradually and progressively increases until the amount of such constituents increases beyond the saturation point when precipitation and deposition of these constituents begins unless steps are taken to prevent it. As the charge becomes supersaturated with the pitch-like constituents, they tend to deposit upon the heating surfaces of the still with consequent danger of overheating and failure of the heating surfaces if the still is not shut down at more or less frequent intervals for cleaning. Initially, the entire charge of oil in the still acts as a solvent for the pitch-like constituents, but, as portions of the charge are cracked and vaporized, the solvent effect of the charge

of oil decreases while the amount of pitch-like constituents increases until finally deposition of pitch-like constituents occurs.

In a prior application filed July 12, 1922, Serial No. 574,380, there is described an improved process of cracking hydrocarbon oils according to which the concentration of pitch-like constituents in the charge is controlled during the operation of the pressure still by withdrawing pitch-laden tar and introducing fresh charging stock at a regulated rate to maintain the pitch content of the charge below the saturation point. In one aspect, the present invention involves a further improvement upon the process described in this prior application, and similarly may involve carrying out the cracking operation with the introduction of fresh charging stock and the withdrawal of pitch laden tar to maintain the pitch content of the charge below saturation.

According to the present invention, the vapors from the pressure still are subjected to a refluxing operation in direct contact with an oil heavier than the desired pressure distillate but including constituents corresponding in character to the desired pressure distillate. The lighter constituents of this oil employed to promote the refluxing operation are more or less completely vaporized by contact with the vapors from the still and the cooling effect of the vaporization effects a sharp refluxing of the heavier vapors, particularly of the constituents heavier than the vaporized constituents. In this way, by regulating the amount and character of the refluxing oil introduced into direct contact with the vapors from the still, a sharp fractionation between the components suitable in the desired pressure distillate and the heavier components can be effected, and the character of the pressure distillate as well as of the refluxed constituents can be more or less closely controlled. The intermediate lighter vapors, heavier than the desired pressure distillate, which are allowed to escape with the pressure distillate, in ordinary methods of operation, are returned to the pressure still from which they have escaped where they assist in maintaining the concentration of pitch-like constituents produced during the progress of the cracking operation below the saturation point in the still charge.

In the process of the present invention, accordingly, the pitch content of the charge of oil in the pressure still may be controlled by withdrawing pitch-laden tar and introducing fresh charging stock in regulated amount while at the same time the light intermediate constituents which usually escape from the still with and form a part of the pressure distillate although too heavy to be suitable as components of the desired products are refluxed to the still charge.

The oil employed for promoting and con-

trolling the improved refluxing operation of the present invention may be a part of the pressure distillate from other pressure stills operated to produce a heavier distillate, or other blends or fractions heavier than the desired pressure distillate but including constituents corresponding in character to constituents of the desired distillate may be employed. Where the operation is carried out with the introduction of additional fresh heavier charging stock, the oil employed for promoting and controlling the refluxing operation may also be introduced into direct contact with the vapors from the still in admixture with all or a part of this additional fresh charging stock. Or, the oil employed for promoting and controlling the refluxing operation may be introduced near the upper end of a reflux tower through which the vapors from the pressure still are passed upwardly and all or a part of the heavier charging stock introduced into the tower at some intermediate point.

As compared to ordinary methods of operation, the introduction into direct contact with the vapors in the reflux tower of an oil heavier than the desired pressure distillate but including a large amount of constituents corresponding to the constituents of the desired pressure distillate and the consequent vaporization of this large amount of lighter constituents from the introduced oil and refluxing of the heavier intermediate constituents from the still may result, where the operation is carried out to produce a very light fraction, in the consumption of an excessive amount of heat in revaporizing in a cyclic manner these intermediate constituents with the resulting decrease in the rate of cracking. This decrease in the rate of cracking may also be accompanied by an inability on the part of the still to maintain, autogenously, the desired pressure due to the decreased rate of production of cracked vapors and fixed gases. In carrying out the process of the present invention, these conditions may be offset, if encountered, in any one of several ways. For this purpose, the still pressure may be maintained by the introduction of an extraneous gas, or the still pressure may be reduced and regulated at a point between the still and the condenser. By operating the pressure still in either of these ways, the proper still pressure can be maintained although the rate of cracking may be somewhat decreased. An increased still pressure, as compared to that employed in ordinary methods, may also be employed to prevent, to a greater or less extent, the revaporization of these intermediate constituents before they are further cracked. The operation of the reflux tower may also be regulated so that the pressure distillate escaping includes a somewhat increased amount of the lighter of these

intermediate constituents which tend to be recycled to an excessive extent between the reflux tower and the still.

Provision may also be made so that the reflux from the refluxing operation, including such intermediate constituents, is positively subjected to the cracking temperature in the pressure still before being permitted to again escape therefrom as a vapor. Where either a shell or a tube still is employed, the reflux from the refluxing operation may be circulated through a separate heater in which it is heated to the cracking temperature and then introduced into the main body of oil in the still. Where a circulatory pressure still is employed, in which the oil is circulated from and to a bulk supply tank through a heater in which it is heated to the cracking temperature, the reflux from the refluxing operation may be returned to the still in a manner such that it is directed through the heater with a circulating oil, or a positive forcing means, such as a pump, may be employed to positively circulate the reflux through the heater, so that it exerts a solvent action in the heater and is subjected to the cracking temperature therein.

The refluxing operation of the present invention may, with particular advantage, be carried out in a heat insulated reflux tower so that heat exchange is confined to the constituents in direct contact in the tower, thereby promoting heat economy, by preventing loss of heat to the air or other external cooling medium, permitting closer regulation and control of the refluxing operation, and effecting a maximum fractionation of the vapors from the still.

While the refluxing operation of the present invention may be carried out in reflux towers of various types, it is carried out with particular advantage in a reflux tower of baffle construction having a relatively large area for free passage of the vapors there-through. A tower of this type offers important advantages in safety and in ease of control, is readily repaired, and has other advantages which will further appear.

The invention will be further described and illustrated in connection with the accompanying drawings which show, in a somewhat diagrammatic and conventional manner, several forms of pressure stills adapted for the practice of the process of the invention; but it is intended and will be understood that the invention is not limited to the specific methods of operation so described.

In the accompanying drawings the three figures represent, in elevation and partly in section, similar views of three arrangements of pressure stills adapted for the practice of the process of the invention. The drawings are not intended to be to scale, for example, the distillate tanks and charging stock tanks illustrated may be materially larger in actual

practice than is shown by the proportions of the drawings.

While the process of the invention may be carried out in pressure cracking stills of different types, it is of special value and application in connection with circulatory pressure stills of the character illustrated. This pressure cracking still is of the general construction and operation described and illustrated in United States Letters Patent No. 1,285,200 granted to the Sinclair Refining Company November 19, 1918 on the application of Edward W. Isom.

The pressure still illustrated is made up of the bulk supply tank 5 located away from the heating furnace, the vertically arranged heating tubes 6 located in the heating flue of the furnace, and circulating pipes 7, 8 and 9 connecting successively the bulk supply tank, a circulating pump 10, the lower end of the heating tubes, and the upper end of the heating tubes and the bulk supply tank. A circulating pump may, with advantage, be employed for circulating the oil from the bulk supply tank through the heating tubes and back to the bulk supply tank; or the circulating pump may be omitted and thermosyphonic action relied upon for maintaining circulation but with decreased still capacity. Arranged above the bulk supply tank is a reflux tower 11 having a series of baffles therein and connected with the vapor dome of the bulk supply tank through the vapor line 12. The vapors from the top of the reflux tower escape through a vapor line 13 to a condenser 14 arranged to discharge into the receiver 15. From the receiver, the condensed distillate is discharged through valved connection 16 and the uncondensed vapors and gases through the valved connection 17. A connection 18 is provided at the lower part of the circulating connections of the still for pumping out and charging the still, and a tar draw-off connection for use during the operation of the still is provided at 19. A connection 20 is also arranged for introducing fresh charging stock into the circulating oil through the bearings of the circulating pump. Where no circulating pump is employed this connection may be arranged to discharge directly into the circulating connections of the still, advantageously in the connection for circulating oil from the bulk supply tank to the heating tubes.

The pressure may be regulated and reduced by means of a regulating valve interposed between the reflux tower and the condenser, or the still pressure may be maintained through the condenser and the pressure regulated and controlled by a suitable valve or valves arranged beyond the condenser. Where an extraneous gas is employed for maintaining the still pressure, the gas pressure may be applied through connec-

tion 17 and the still, condenser and receiver maintained in open communication.

More particularly referring to the apparatus illustrated in Fig. 1, a pump 21 is arranged to force oil through connection 22 to a spray-head 23 in the upper end of the reflux tower, and through it into direct contact with the vapors in the reflux tower. This pump is arranged to draw distillate from the separate distillate tank 25. A connection 26 is provided for returning reflux, and any unvaporized constituents of the oil introduced into the reflux tower, to the circulating connection 7 on the suction side of the circulating pump 10. The reflux tower is advantageously provided with a heat insulating jacket (not shown) of suitable material, such as asbestos or mineral wool; and the other exposed parts of the pressure still may also with advantage be covered with heat insulating material to prevent unnecessary heat loss and to promote heat economy. A pump 27 is arranged to force fresh charging stock from any suitable source into the pressure still through connections 20 and the bearings of the circulating pump.

In carrying out the cracking process of the present invention in the apparatus illustrated in Fig. 1, the still is charged with fresh charging stock in the usual way, for example through connection 18, and brought to the cracking temperature and pressure in the usual manner. The charging stock, for example, may be gas oil or other suitable charging stock which is to be cracked for the production of gasoline or pressure distillate. The pressure maintained in the still during the cracking operation can vary, depending upon the character of the charging stock and other considerations. For example, with a gas oil charging stock and for the production of gasoline a pressure up to 125 lbs. per sq. inch or more can be used. After cracking conditions of temperature and pressure are reached, cracking begins and takes place in a gradual and progressive manner, the vapors liberated in the still proper escaping and passing upwardly through the reflux tower. At this point, or shortly thereafter, the introduction through connection 22 of an oil containing a large amount of constituents corresponding to the constituents of the desired pressure distillate from a separate source, such as tank 25, is begun. As the distillation proceeds, the still charge is maintained by the introduction of additional charging stock, for example gas oil, through the bearings of the circulating pump; and before the pitch content of the charge reaches the saturation point, the withdrawal of tar through connection 19 is begun and the rate of tar draw-off and of fresh charging stock feed is regulated to maintain the pitch content of the charge below the saturation point.

The lighter portion of the oil introduced into the reflux tower is vaporized to a greater or less extent by heat exchange with the vapors from the still and the heavier constituents of the vapors are refluxed by the cooling effected by the vaporization. The extent to which the refluxing oil is vaporized depends in large part upon the character of the refluxing oil. Since the constituents of the refluxing feed which are vaporized correspond in character to the desired distillate, heavier components are not introduced into the distillate to any great extent by employing such a feed as a refluxing medium. At the same time, a sharp fractionation is effected and the constituents of the vapors heavier than the vaporized constituents of the feed introduced into the reflux tower are refluxed and returned to the still through connection 26 together with the unvaporized constituents of the oil introduced into the reflux tower. As compared to an operation in which heavier charging stock is employed alone as a refluxing agent, however, the lighter feed for promoting and controlling the refluxing operation has a reduced tendency to carry back to the still constituents suitable as components of the desired pressure distillate. As is shown in the drawing, the reflux is returned to the suction side of the circulating pump so that it is redirected through the heating tubes where it is subjected to the cracking temperature in admixture with the circulating oil in the still before being introduced into the main body of oil in the still or before it can again escape from the still proper as a vapor. The refluxed constituents are thus returned and admixed with the circulating still charge where they assist in maintaining pitch like constituents in solution and where they are subjected to further cracking. For example, in the production of a 450° F. end-point gasoline and with a feed to the reflux tower comprising a major part of gasoline constituents boiling below 450° F., a major part of the constituents of the vapors from the still boiling between about 450° F. and 500° F. and substantially all of the heavier vapors can be refluxed to the still, and, by proper regulation, a gasoline character fraction can be directly produced. The refluxing operation, however, may be regulated so that a pressure distillate including a larger amount of heavier components is produced.

The following is an example of the practice of the present invention as carried out in a still of the character just described:

The still was charged with 10,000 gallons of gas oil charging stock. The still charge was heated, drips were taken off, and the charge was brought to a working pressure of about 125 pounds per square inch. The still was then opened to the condenser and the

distillate began to pass over. At about the same time the introduction of a distillate including about 50% of 450° F. end-point gasoline into the reflux tower was begun while additional gas oil charging stock was introduced through the pump bearings. Before the pitch-content of the charge reached the saturation point, the withdrawal of tar was begun and continued throughout the remaining portion of the run. The rate of tar draw-off and gas oil feed were regulated to maintain a substantially constant still charge. In this run additional gas oil to the amount of 21,210 gallons was fed into the still during the operation, 19,820 gallons of distillate were introduced into the reflux tower, and 16,345 gallons of tar were withdrawn, the total distillate amounting to 25,970 gallons. This distillate included 22,070 gallons, or about 85%, of 450° F. end-point gasoline, or the net gasoline production was 12,160 gallons. The run lasted 26¾ hours and during this time circulation in the still was maintained at the rate of about 2,000 gallons per minute.

In another run, the still was charged with 10,000 gallons of gas oil and brought to a working pressure of about 125 pounds per square inch, the total period of operation being 29 hours. During this time, additional gas oil to the amount of 22,770 gallons was introduced through the pump bearings, 23,520 gallons of a distillate including 50% of 450° F. end-point gasoline was introduced into the tower, 18,012 gallons of tar were withdrawn to inhibit increase in the concentration of pitch in the still charge, and a distillate of 28,300 gallons was produced. This distillate included 24,050 gallons, or about 85%, of 450° F. end-point gasoline, or the net gasoline production was 12,290 gallons.

While the invention is of particular advantage in connection with processes in which the concentration of pitch-like constituents in the still charge is controlled by the regulated introduction of charging stock and withdrawal of tar, certain advantages of the invention in the operation of a circulatory pressure still of the type just described are obtained in a batch operation, that is in an operation in which no tar or only a relatively small amount of tar is withdrawn. In particular, the return of intermediate constituents to the oil circulating through the heating tubes by the improved refluxing operation of the invention increases the solvent effect of the still charge where the oil is subjected to the highest temperatures and assists in reducing the deposition of pitch-like constituents upon the heating surfaces of the still. Such an operation can be carried out with or without the introduction of fresh charging stock during the progress of the operation: where fresh charging stock is so introduced it further assists in maintaining pitch-like

constituents formed by the cracking operation in solution in the charge.

In the apparatus illustrated in Fig. 2 similar parts are designated by the same reference numerals with the distinguishing character "a" appended thereto. The apparatus illustrated in Fig. 2 differs in construction and operation from that shown in Fig. 1 principally in the arrangement of the means for introducing fresh charging stock during the progress of the cracking operation and in the provision of a pump for positively forcing reflux and admixed feed oil through the heating tubes with the circulating oil in the still proper.

In addition to the connection 26a for returning reflux to the suction side of the circulating pump 10a, connections 29 and 30 and pump 31 are arranged for positively forcing reflux from the reflux tower into the oil circulating to the heating tubes in the still through the lower circulating connection 8a. Valves 29' and 26' provide for the direction of the reflux either through the reflux circulating pump 31 or through the overflow connection 26a as may be desired.

Pump 21a is arranged to force distillate containing a large amount of constituents corresponding to the constituents of the desired pressure distillate from any suitable source delivered through connection 34, into the upper end of the reflux tower through sprayhead 33 and connection 32. The pump 28 is arranged to force additional fresh heavy charging stock from the supply tank 35 into the pressure still through connection 20a and the bearings of the circulating pump 10a, into the reflux tower at an intermediate point through the sprayhead 36 and connection 37, or into the upper end of the reflux tower through connections 38 and 32. The heavier charging stock may be introduced into the still through one or more of these channels at the same time and valves 20', 37' and 38' are provided in the respective connections to control and regulate the distribution of the additional heavy charging stock.

In one way of carrying out the process of the invention in the apparatus illustrated in Fig. 2, the heavier charging stock may be introduced into the reflux tower at an intermediate point through connection 37 and the lighter oil for controlling and regulating the refluxing operation introduced into the upper part of the reflux tower so that the final separation between the heavier constituents and the constituents suitable as components of the desired pressure distillate is effected in the upper part of the tower above the point of introduction of the heavier feed. Or, all or a part of the heavier charging stock introduced into the reflux tower may be introduced into the upper end of the tower in admixture with the lighter oil for controlling and regulating the refluxing operation, in

which case the lighter constituents of the mixture will be vaporized in the reflux tower, promoting and controlling the refluxing operation in a manner similar to that which has been described. In addition to the heavier charging stock introduced into the reflux tower, additional heavy charging stock may be forced into the pressure still through the bearings of the circulating pump, or at some other point where it does not contact with the vapors escaping from the still. To the extent that the heavier charging stock is introduced into direct contact with the vapors in the reflux tower, it assists in promoting the refluxing operation and is thereby preheated. A somewhat more effective separation of the heavier constituents may be effected, however, by introducing the major part of the heavier charging stock introduced into the tower at an intermediate point and by introducing the lighter oil for controlling and regulating the refluxing operation into the upper part of the tower.

The reflux from the reflux tower may be returned through connection 26a and admixed with the oil circulating from the bulk supply tank to the heating tubes as has been described in connection with Fig. 1; or the reflux may with advantage be positively forced into the oil circulating through the heating tubes by pump 31 so that it is subjected to the cracking temperature in admixture with the circulating still charge in the heating tubes before it is returned to the main body of oil in the bulk supply tank or before it can escape as a vapor therefrom. The reflux is thus compelled to circulate through the heating tubes in admixture with the circulating pitch-containing oil so that it assists in preventing the deposition of pitch upon the heating surfaces and so that it is necessarily subjected to the cracking temperature in the heating tubes.

In the apparatus illustrated in Fig. 3 the same parts are designated by the same reference numerals with the distinguishing character "b" appended thereto. In this modified form of the apparatus an auxiliary heating coil 39 is arranged in the heating flue of the furnace between the fire-box and the vertical heating tubes so that the auxiliary coil is subjected to the hottest heating gases and the main heating tubes to the tempered heating gases which have passed over the auxiliary coil. This auxiliary coil is arranged so that the reflux from the reflux tower, either with or without the admixture of fresh charging stock, is circulated there-through, thus subjecting the reflux to the hottest heating gases and at the same time protecting the heating surfaces over which the pitch containing charge of oil in the still proper is circulated.

For this purpose an auxiliary tank or reservoir 40 is arranged to receive the reflux

from the reflux tower through connection 41. This tank or reservoir has a vent pipe 42 leading back to the reflux tower. A valved connection 43 is also provided for discharging reflux from the reflux tower directly into the bulk supply tank 5b. The tank 40 is also connected through the pipes 44 and 45 to the feed line of the auxiliary coil. A pump 46 is arranged to pump the oil from the tank 40 through the auxiliary coil, while the connecting pipe 47 permits circulation by gravity and by convection when the pump 46 is not used. A branch pipe 48 leads from connection 44 to the bottom of the bulk supply tank for supplying additional oil in case the amount of reflux is insufficient to maintain full the auxiliary coil. A connection 49 is also provided for circulating fresh charging stock through the auxiliary coil if desired. A connection 51 is arranged between the inlet 45 of the auxiliary coil and the discharge side of the circulating pump 10b, and may be used in starting the still in operation as well as in draining the auxiliary coil and connection piping when the still is pumped out. The auxiliary coil 39 is arranged to discharge through connection 52 into the return circulating connection 9b to the bulk supply tank.

The auxiliary reservoir or tank 40 is shown as located within the bulk supply tank 5b, although it is not in open communication therewith except through the pipe connections. This location of the auxiliary reservoir is not essential but it is convenient and enables a tank construction to be used which does not need to withstand high pressure as the pressure inside and out is approximately the same.

In carrying out the process of the invention in the apparatus illustrated in Fig. 3, the reflux tower may be operated in much the same way as has been described in connection with Figs. 1 and 2. A lighter oil for controlling and regulating the refluxing operation is introduced into the upper end of the tower, and additional heavier charging stock may be introduced into the pressure still through the bearings of the circulating pump, into the reflux tower at an intermediate point, into the upper end of the reflux tower in admixture with the lighter oil, or through two or more of these channels in combination. The reflux from the reflux tower, together with any admixed feed oil, however, is circulated through the auxiliary coil 39 before it is returned to the main body of oil in the still or before it can escape from the pressure still as a vapor. The reflux is thus positively subjected to the cracking temperature, and, moreover, in the apparatus illustrated, is subjected to the hottest heating gases. If the supply of reflux is for any reason insufficient to maintain full the auxiliary coil, additional oil is supplied thereto either from the bulk supply

tank through connection 48, from the circulating connections through connection 51, or from an external supply through connection 49. Additional fresh oil may also be forced through the auxiliary coil through connection 49 to assist in absorbing heat from the hottest heating gases to further protect the main heating surfaces of the still proper.

In carrying out the process of the present invention for the production of a gasoline character distillate from a heavier hydrocarbon oil, a distillate containing a gasoline fraction which it is desired to blend with the pressure distillate may be employed as the refluxing agent and may be introduced into the reflux tower in direct contact with the hot vapors from the still for this purpose. For example, a straight run fraction containing gasoline which it is desired to blend with the cracked gasoline may be introduced into the reflux tower in this way. The gasoline constituents of the fraction introduced into the reflux tower are vaporized by heat exchange with the hot vapors therein and at the same time reflux to the still the heavier constituents of the vapors. The gasoline constituents of the fraction are thus employed to promote and control the refluxing operation while at the same time they escape with the pressure distillate and are condensed therewith so that the blending operation is carried out in an improved manner.

One of the important advantages of the invention is that it enables the production of a pressure distillate containing the desired constituents in increased concentration. This enables a marked reduction in the cost of refining the pressure distillate, for example in the further treatment of the pressure distillate for the production of a finished gasoline therefrom, in that the amount of pressure distillate it is necessary to handle per gallon of desired products is materially reduced. Less equipment is required both for chemically treating and for redistilling the distillate, and the cost of labor, chemicals and fuel for such further treatment is also reduced. The distillate is also relatively free from heavy or tarry constituents of the fresh oil or still charge and the amount of heavier constituents in the pressure distillate which may tend to carry with them objectionable impurities or otherwise interfere with the refining operations is reduced, further facilitating the refining treatment. The process of the present invention also enables the production of an increased amount of gasoline, of the desired pressure distillate, due in part to the better fractionation effected in the reflux tower on the pressure still and in part to a reduction of the amount of gasoline constituents returned to the pressure still with the reflux and subjected to further cracking therein. One evidence indicating a decrease in overcracking of constituents suitable as

components of the desired distillate is a decrease in the production of fixed gas. In one case, the amount of fixed gas produced per hundred gallons of charge was reduced to 18 to 20 pounds as compared to 21 to 22 pounds with the ordinary method of operation. Another important advantage of the invention is that it enables the production of an increased yield of gasoline or pressure distillate on the oil charged to the still. Due to the improved separation effected in the reflux tower, less of the pressure distillate constituents are refluxed to the still and the amount of constituents heavier than the desired pressure distillate escaping with the pressure distillate is also reduced. In the production of gasoline from gas oil, for example, the amount of fresh charging stock introduced during the progress of the cracking operation can be reduced by an amount corresponding to the amount of gas oil ordinarily removed with the pressure distillate, and the heat ordinarily used in preheating this amount of gas oil to the cracking temperature can be employed in effecting the cracking operation. The amount of heat ordinarily used to revaporize in the still pressure distillate constituents returned to the still, and in some cases in further cracking them, can also be applied to the cracking operation. A more concentrated application of the heat to the cracking of the pressure still charge is thus obtained. As compared to ordinary methods of operation in which constituents which might be further cracked to produce additional gasoline escape with the distillate and in which gasoline constituents are refluxed and overcracked the yield of gasoline on the gas-oil charged to the still may be increased from 2 to 6% or more. An important economy may also be effected in the amount of cooling water, or of other cooling medium, required for cooling and condensing the pressure distillate due to the concentration of the pressure distillate, and the size of the condenser employed may be correspondingly reduced. These factors may also assist in making possible a material saving of fuel.

The process of the present invention also has important advantages as applied to the direct production of a gasoline character distillate in the ease of control which it affords and in the simplicity of the operation. Moreover, in carrying out the present invention, a reflux tower of ordinary baffle construction may be employed with advantage. Such a tower does not materially restrict the escape of vapors from the still and a relatively large area for their free escape is provided thereby reducing any danger due to sudden generation of vapors. Likewise, the path of the vapors through the tower is relatively short and the heat exchanging relations maintained between the constituents in a reflux tower of the baffle type are comparatively

simple affording direct and substantially immediate control. A single tower of this type is, moreover, adapted to produce a wide range of products by appropriate control of the refluxing operation carried out therein.

5 While various features of the process which have been described may be employed conjointly with particular advantage, for example, while the refluxing operation may be
10 carried out in a heat insulated reflux tower of baffle construction employed in conjunction with a circulatory pressure still with directed return of the reflux with the oil circulating to and through the heater, it will
15 be apparent that certain novel features of the invention may be employed alone with advantage, and that many features of the process of the invention can be carried out in other and different types of pressure still systems.
20 I have endeavored to define the invention in the subjoined claim and to distinguish it from the prior art so far as known to me without, however, relinquishing or abandoning any portion or feature thereof.

25 I claim:

An improved method of cracking hydrocarbon oils, which comprises heating a body of the oil to a cracking temperature under pressure in a pressure still, passing the vapors
30 from the still upwardly through a reflux tower, passing uncondensed vapors from the reflux tower to a condenser to produce a distillate, introducing an oil heavier than said distillate and including a substantial quantity of constituents corresponding in character to constituents of the distillate into direct
35 contact with the vapors in the upper end of the reflux tower, introducing a heavier oil into direct contact with the vapors at an intermediate point in the reflux tower, and returning
40 reflux without substantial cooling from the tower to the still.

In testimony whereof I affix my signature.

EUGENE C. HERTHEL.

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