

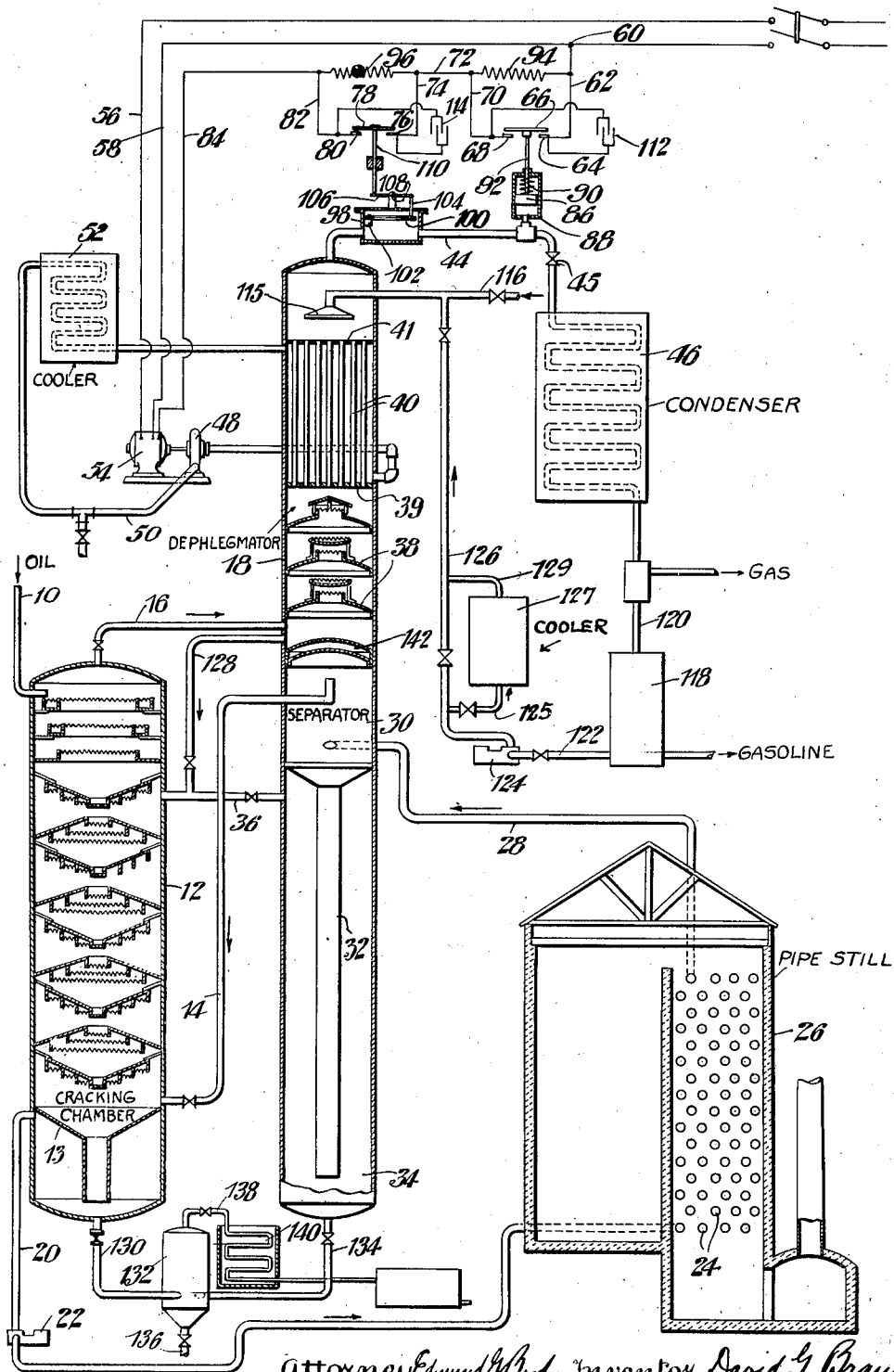
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CONSTANT PRESSURE AND TEMPERATURE DISTILLATION

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CONSTANT PRESSURE AND TEMPERATURE DISTILLATION

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My invention relates to the cracking distillation of petroleum. It has been known heretofore to crack non-gasoline petroleum oils under pressure and temperature conditions such that commercial quantities of gasoline are obtained. In such processes great difficulty has been experienced in obtaining a sharp separation of the gasoline vapors which it is desired to condense from the heavy vapors always present in the cracking still or chamber and which it is desired shall remain there not only on account of the fact that they may be cracked into gasoline vapors if they remain in the cracking apparatus, but also on account of trouble and expense of separating the heavier material if it appears in the condensate. If hydrocarbons having boiling points above that of a desired end boiling point are present in the commercial gasoline, serious difficulties are met with by the consumers as to starting ignition and deposition of carbon in the engines. In order to prevent the carrying over of the undesired vapors into the condenser, dephlegmators have been used having cooling coils therein. Also crude oil, condensate, and steam have been injected into the dephlegmating apparatus to throw back undesired vapors. A slight decrease in pressure has resulted in a rush of vapor to the condenser resulting in carrying over heavy vapors by entrainment. In endeavoring to correct this condition, the temperature has risen with the pressure so that heavy vapors passed over by boiling or the output of the still has been unduly checked. As it is commercially impossible to provide raw oil of absolutely uniform composition for the cracking processes, no sooner have the operatives succeeded in establishing constant pressure and temperature conditions than they are upset by a variation in the rate of evolution of cracked vapors in the cracking chamber which requires renewed manipulation of the apparatus. A partial solution of the dephlegmation problem has been achieved by the use of one or more intermediate condensers, but this plan greatly increases the cost of the distillation and is commercially equivalent to improving the quality from a distillation without the inter-

mediate condensers by decreasing the output.

As a result of the conditions discussed above, there is no process known to me in which cracked vapors are taken directly from a dephlegmator to a condenser which is giving desired results as to quality or quantity of product or both and in which the labor costs are not higher than are theoretically necessary or desirable.

I have discovered that pressure benzene of substantially fixed end boiling point can be obtained from a condenser connected directly to a dephlegmator of a cracking still or chamber by spraying volatile cooling fluid into the dephlegmator and at the same time varying the cooling produced in the dephlegmator in accordance with both the pressure and temperature of the vapors in the cooler end of the dephlegmator or in the off-take pipe therefrom. I find, moreover, that it is important that the cooling liquid injected into the dephlegmator be substantially entirely vaporized as it is injected, as otherwise severe pressure and temperature variations are set up, the effects of which it is impracticable to avoid.

The present invention embraces not only the process embodying said discovery, but also an apparatus adapted to operate in accordance with my said process. The novel features of the invention are pointed out with particularity in the appended claims.

The various features of the invention together with further objects and advantages thereof, will best be understood from the following description taken with the accompanying drawing, in which

The figure is an elevational view partly in section and somewhat diagrammatic, illustrating an apparatus embodying a preferred form of my invention.

In the drawing, 10 is a pipe for introducing raw oil into the upper portion of a cracking chamber 12, whence it flows downward over a series of pans and trays against an upward current of vapors and gases heated to cracking temperature and introduced into the cracking chamber 12 through pipe 14. The lighter portion of the oil introduced through pipe 10 flows off with the gases and a portion

of the vapors introduced through pipe 14 through pipe 16 which connects the top of chamber 12 with the lower portion of a dephlegmator 18. In the normal operation of the apparatus, the dephlegmator 18 is maintained in open communication with the still 12 by means of the vapor line 16. Petroleum or oil from pipe 10 which passes in liquid condition through the upwardly moving column of hot vapors and gases collects in the lower part of chamber 12 and the greater portion of such liquid is led off from the lower portion of chamber 12 through pipe 20 which connects with chamber 12 just below the partition 13. A pump 22 is connected in pipe 20 which forces oil from cracking chamber 12 through a series of heating coils of a pipe still 24 arranged in a suitable heating chamber 26. In chamber 26 the oil is heated to a cracking temperature but the conditions of pressure and velocity of flow in the pipe still 24 are such that substantially no cracking occurs in this still. From still 24, pipe 28 leads the oil to a separating chamber 30, in which gases and vapors are separated from such of the oil as remains liquid under the conditions in this chamber. The pipe 14, previously mentioned, leads out from the upper portion of chamber 30 and carries the hot gases and vapors therefrom into the lower portion of chamber 12 as previously mentioned. Liquid oil from chamber 30 passes downward through a funnel 32 to the lower portion of chamber 34, and thence upward to the upper portion of chamber 34 and out through pipe 36 and into the upper portion of cracking chamber 12, at a point below the level of the admission of raw oil. The heated oil flowing through pipe 36 into chamber 12 mingles with the raw oil coming down from pipe 10.

The present invention is concerned more particularly with the control of the cracking process by which the most effective cracking pressure and temperature may be maintained under the constantly changing conditions of the distillation. This control is secured through the dephlegmation of the vapors set free from the main body of oil in the still whereby the completely cracked vapors pass on to a final benzine distillate condenser and the higher boiling point vapors which are capable of further cracking are condensed and returned to the still. It is through the dephlegmation and condensation of the vapors that both the cracking temperature and cracking pressure are controlled.

One means of controlling the dephlegmation of the vapors consists of a heat interchange between the vapors and a cooling liquid through a diaphragm. To accomplish this vapors entering the lower portion of dephlegmator 18 through pipe 16 pass upwardly through a series of trays 38 or the like, thence through a set of liquid cooled tubes 40,

which extend between tube sheets 39 and 41 within dephlegmator 18, and thence out of the upper end of the dephlegmator by pipe 44 through a valve or other flow restricting device 45 to condenser 46. Cooling liquid is circulated around the cooling pipes or tubes 40 by means of a pump 48 in a pipe circuit 50, the pipe circuit 50 running through a water tank 52 or other suitable cooler, and the circulation being preferably in such direction that the cooling liquid is withdrawn from a point adjacent the lower ends of the tubes 40 and returned after passing the cooler 52 to a point adjacent the upper ends of said tubes. The liquid in the cooling circuit 50 for cooling the tubes 40 is preferably maintained at a pressure above that of the gases in dephlegmator 18 so that in case of leakage around tubes 40 no vapors will escape. Also I prefer to use a hydrocarbon liquid of the same composition as the oil being distilled for cooling tubes 40 to avoid possible introduction of anything into the hot oil by leakage through the tubes or tube sheets which might interfere with the distillation.

The pump 48 is driven by an electric motor 54. As illustrated in the drawing, the speed of the motor 54 and consequently the cooling effect on the vapors passing up through tubes 40, is varied automatically in accordance with both the temperature and pressure of the vapors passing off from the upper end of the dephlegmator 18 to condenser 46. In the arrangement illustrated in the drawing, this result is effected by varying the amount of resistance in the field circuit of motor 54 in accordance with the temperature and pressure of the gases passing to condenser 46. The armature circuit of motor 54 comprises wires 56, 58 and the field circuit of motor 54 is taken off of lead or wire 58 at point 60. When the temperature and pressure of the vapors passing through pipe 44 to the condenser are both within the desired limits, the field circuit of motor 54 passes from the point 60 through wire 62, contact 64, make and break contact plate 66, contact 68, wires 70, 72 and 74, contact 76, contact plate 78, contact 80, wire 82 and wire 84 to the motor field. If now the pressure of the vapors in pipe 44 rises above that desired, the piston 86 in piston chamber 88 connected to pipe 44 is forced upwardly against the pressure of spring 90 and the contact plate 66, connected to piston 86 by stem 92, is lifted and the circuit previously traced is broken between contact 64 and 68. In this case, current for the field of motor 54 passes through resistance 94 connected between the wires 62 and 70 in shunt to contacts 64 and 68.

Also, in case the temperature of the gases leaving dephlegmator 18 is higher than desired, a thermostatic arrangement raises the contact plate 78, forcing current for the field of the motor 54 to flow through resist-

ance 96 connected between the ends of wires 74 and 82 and in shunt to the contacts 76 and 80. In the arrangement illustrated, the thermostatic means just mentioned comprises a chamber 98 in free communication with the outlet pipe 44 from dephlegmator 18, and containing a thermostat 100. As illustrated, the thermostat 100 comprises two thin strips of metal having unequal coefficients of expansion, said strips being fastened together along one base and supported at their one ends by suitable means as, for instance, by block 102, fixed to the inner face of chamber 98. The other ends of the thermostatic strips 100 are free to move in the chamber 98 in accordance with variations in temperature, and have fixed thereto a wire 104 running through the wall of the chamber 98 and connected outside said wall to one end of the lever 106. The lever 106 is pivoted at 108 to a suitable fixed support and the other end of the lever 106 is adapted to contact with the spindle 110 fixed to the contact plate 78 previously mentioned. If now the temperature of the vapors in pipe 44 and chamber 98 is below the desired maximum, the outer end of the thermostat 100, as illustrated in the figure, moves upwardly, turning the lever 106 in a counterclockwise direction around its pivot, and permitting the plate 78 to connect contacts 76 and 80. The spindle 110 of the plate 78 is not fixed to lever 106, so that the lever is free to move in the counterclockwise direction after the plate 78 is seated on its contacts, and no strain is placed upon the parts of the thermostatic apparatus by a further fall in temperature of the vapors. If now the temperature of vapors in chamber 98 rises above that desired, the thermostat 100 moves in an opposite manner to that just described, the wire 104 being fixed to one end of lever 106 to turn the lever in a clockwise direction around a pivot and to lift the spindle 110 and plate 78 at the point desired. Resistance is thus introduced into the motor field circuit and the motor speeded up to increase the cooling effect. I prefer to use condensers 112 and 114 across the contacts 64, 68, 76 and 80, respectively, to prevent sparking when the plates 66 and 78 are lifted from their contacts.

While I have shown the pressure controlled member 86 and the temperature controlled member 100 as operating the plates 66 and 78 directly, it will be understood that I have illustrated the pressure responsive apparatus and the temperature responsive apparatus in this way, primarily to simplify the drawing, and that in practice I shall probably arrange the pressure responsive element and the temperature responsive element to control directly individual relays, the relays controlling circuits for opening and closing the circuits around the resistances 94, 96, in a way

well understood by those in the electrical trades.

Another means of controlling the dephlegmation of vapors from the still consists in spraying a cooling liquid into the vapors after they have been cooled by passing through the tubes 40. To accomplish this a spray head 115 is mounted in the dephlegmator above the tubes 40 and cold water may be introduced into the head through a valved pipe 116 or cooled pressure benzine may be introduced into the head through a valved pipe 126. Both water and pressure benzine are completely vaporized in the vapors and thus increase the concentration of the light vapors and provide an effective means of controlling the pressure in the dephlegmator. By varying the amount of volatile liquid inserted into the dephlegmator vapors the volume of the vapors in the dephlegmator may be maintained substantially constant and by this means the pressure in the still and dephlegmator may be easily controlled. Further the sensible heat of the water or benzine as well as their heats of vaporization may be used for controlling the temperature of the vapors passing through the dephlegmator. The water or benzine must be introduced into the dephlegmator at a pressure above the dephlegmator pressure. Accordingly high pressure water is supplied to the valved pipe 116 or the benzine condensed in condenser 46 passes through a pipe 120 to a tank 118 from which it is drawn through a pipe 122 and forced by a pump 124 into the pipe 126.

It will be understood, further, that I do not limit myself to varying the cooling of the vapors passing out of dephlegmator 18 in any particular way, provided the means employed maintains substantially constant pressure and constant temperature in the dephlegmator at the point of exit of the exit gases going to the condenser. For instance, instead of varying only the cooling effect of the tubes 40, I may maintain the cooling effect of the tubes 40 substantially constant and obtain the necessary variations in cooling effect by variations in the temperature and volume of liquid introduced through the spray head 115, or I may use any combination of means for varying the cooling effects of both the tubes 40 and the spray. The temperature of the benzine introduced through the pipes 126 and 116 may be varied by bypassing a portion or all of the benzine delivered by the pump 124, through a valved pipe 125 into a cooler 127 in which the benzine may be cooled to the desired extent and reintroduced by a pipe 129 into the pipe 126. Suitable valves are provided in pipes 126 and 129 for controlling the proportion of benzine passed through the cooler and that passed directly through the pipe 126 to the pipe 116.

Heavier liquid fractions thrown back by

the dephlegmator 18 due to its air cooled circuit and the cooling effect of the tubes 40 and the spray from 115 collect in the bottom of dephlegmator 18 and are led back into the cracking chamber 12 through pipe 128 which connects with pipe 36 previously mentioned.

In order to control the average density of the oil flowing in the circuit through pipe 20, pump 22, heating coil 24, pipe 28, chambers 30 and 34, pipe 36, and chamber 12, are provided means for drawing off liquid from the bottoms of both chambers 12 and 34. From the bottom of chamber 12 I take out pipe 130 going to the lower part of the tank 132, and from the bottom of chamber 34 I take off pipe 134, also entering the lower part of tank 132. A pipe 136 leads from the lower portion of the tank 132 to a suitable storage receptacle and pipe 138 leads from the upper portion of tank 132 through a condenser 140 to a suitable storage. Valves are indicated at various points in the piping of the cracking system described above, whereby any desired pressure may be maintained in the system and the density of the liquids in the various portions of the system regulated as desired. As I prefer to combine the dephlegmator 18 in one structure with the chambers 30 and 34 and as there is considerable difference in temperature between chamber 30 and the lower portion of dephlegmator 18, I place a heat insulating partition 142 between intermediate chamber 30 and dephlegmator.

While I have described a particular embodiment of my invention suitable for the actual practice thereof, I do not limit myself to details of the foregoing disclosure except in so far as such details are expressly included in the appended claims.

Having thus described my invention, I claim:

1. A method of dephlegmating hydrocarbon vapors comprising injecting a liquid into a dephlegmator near the vapor off-take thereof, completely vaporizing said liquid as it is injected, and automatically cooling the vapors in the dephlegmator in response to variations in both the pressure and temperature of the off-take vapors.

2. A method of distilling heavy hydrocarbon oils to obtain lighter hydrocarbon oils therefrom comprising heating heavy hydrocarbon oil in a still, passing vapors set free in the still through a dephlegmating condenser to return higher boiling fractions of the vapors to the still, maintaining the dephlegmator in open communication with the still, conducting vapors leaving the dephlegmator through a restriction arranged to maintain a high pressure in the still and dephlegmator, maintaining the restriction substantially constant and controlling the pressure and temperature of the vapors passing through said dephlegmator by injecting into

the vapors a cooling liquid completely vaporizable at the temperature of the vapors.

3. A method of distilling heavy hydrocarbon oils to obtain lighter hydrocarbon oils therefrom comprising heating hydrocarbon oil having boiling points above 500° F. in a still, passing vapors set free in the still through a dephlegmating condenser to return higher boiling point fractions of the vapors to the still, maintaining the dephlegmator in open communication with the still, conducting vapors leaving the dephlegmator through a restriction arranged to maintain a high pressure in the still and dephlegmator, maintaining the restriction substantially constant and controlling the pressure and temperature of the vapors passing through the dephlegmator by injecting water into the vapors.

4. A method of distilling heavy hydrocarbon oils to obtain lighter hydrocarbon oils therefrom comprising heating the heavy hydrocarbon oils in a still, passing vapors set free of the still through a dephlegmating condenser to return higher boiling fractions of the vapors to the still, maintaining the dephlegmator in open communication with the still, conducting vapors leaving the dephlegmator through a restriction arranged to maintain a high pressure in the still and dephlegmator, maintaining the restriction substantially constant and controlling the pressure and temperature of the vapors passing through said dephlegmator by injecting into the vapors a cooling liquid completely vaporizable at the temperature of the vapors and by cooling the vapors by a heat interchange through a diaphragm with a cooling fluid.

5. A method of distilling heavy hydrocarbon oils to obtain lighter hydrocarbon oils therefrom comprising heating heavy hydrocarbon oils in a still, passing vapors set free in the still through a dephlegmating condenser to return higher boiling point fractions in the vapors to the still, maintaining the dephlegmator in open communication with the still, conducting vapors leaving the dephlegmator through a restriction arranged to maintain a high pressure in the still and dephlegmator, maintaining the vapor restriction substantially constant and holding the pressure and temperature of the vapors passing through the dephlegmator substantially constant by cooling the vapors by heat interchange through a diaphragm with a cooling liquid, the quantity of which passing into contact with the diaphragm may be accurately controlled and by spraying into the vapors a cooling liquid completely vaporizable at the temperature of the vapors.

6. A dephlegmating apparatus comprising in combination a dephlegmator, cooling means in said dephlegmator, means for spraying liquid into said dephlegmator above said cooling means, valve means for maintaining pressure in said dephlegmator and

automatic means for varying the action of said cooling means in accordance with the changes in pressure and temperature in the dephlegmator.

5 7. The combination of a dephlegmator having a vapor outlet, and means for cooling the vapors in said dephlegmator controlled both by the temperature and pressure of the vapors passing out of said dephlegmator.

10 8. The combination of a dephlegmator, a set of tubes in said dephlegmator through which the vapors pass upwardly toward the outlet, means for circulating cooling liquid around said tubes, a liquid spray above said tubes in said dephlegmator and means for controlling the circulation of said liquid in accordance with both the pressure and the temperature of said vapors after passing said spray.

15 9. A method of distilling heavy hydrocarbon oils to obtain lighter hydrocarbon oils therefrom, comprising heating heavy hydrocarbon oil in a still, passing vapors set free in the still to a dephlegmator to return higher boiling point fractions of the vapors to the still, maintaining the dephlegmator in open communication with the still, conducting the vapors leaving the dephlegmator through a restriction arranged to maintain a high pressure in the still and dephlegmator, adding a volatile liquid into the dephlegmator vapors to maintain a substantially constant volume of vapors for controlling the pressure in the still and dephlegmator, said volatile liquid being adapted to be substantially completely vaporized in said dephlegmator, and maintaining the temperature of the vapors in the dephlegmator substantially constant by controlling the temperature of the said volatile liquid and by cooling the vapors passing through the dephlegmator.

20 10. In a process of distillation, the method of subjecting vapors to cooling and partial condensation, which comprises automatically varying the degree to which said vapors are cooled in response to variations in the temperature of vapors cooled by said cooling and the pressure exerted by said vapors.

25 11. The method of dephlegmating vapors comprising cooling said vapors by means of a circulating liquid cooler than the vapors, and automatically controlling the circulation of said liquid in response to variations in both the pressure and the temperature of said vapors.

30 12. The method of dephlegmating vapors comprising cooling said vapors by a circulating liquid cooler than said vapors, spraying liquid into said vapors at a point in their path subsequent to said circulating liquid, said liquid being vaporizable at the temperature of the vapors at the point at which the liquid is injected therein, and controlling the circulation of said circulating liquid by the pressure and temperature of said vapors at a point

in their course subsequent to that of injecting said vaporizable liquid.

35 13. An apparatus for cracking heavy hydrocarbon oils comprising a cracking chamber, a dephlegmating apparatus receiving vapors from said chamber, means within said apparatus for cooling said vapors by a relatively cool circulating liquid, means for conducting reflux liquid from said apparatus to said chamber, and means whereby the circulation of said liquid is controlled by the pressure and temperature of the vapors after leaving said cooling means.

40 14. In the distillation of petroleum, the process, which comprises passing vapors through a partial condenser and into a final condenser, cooling the vapors in the partial condenser to condense the higher boiling portions of the vapors and automatically varying the degree of said cooling in response to variations in the temperature and pressure of the vapors in the partial condenser passing to the final condenser.

45 15. A reflux condenser comprising means for conducting vapors through said condenser, a cooler, means for circulating a cooling fluid in a closed cycle through said cooler and in indirect heat exchange with the vapors passing through said condenser and means responsive to the variations in the temperature and pressure of the vapors leaving said condenser for varying the quantity of cooling fluid passing through said cycle.

50 16. In apparatus for fractionating vapors, a partial condenser and a final condenser, means for conducting vapors from the partial condenser to the final condenser, means for passing a liquid in heat exchange with vapors in said partial condenser, and automatic means responsive to variations of the pressure in the partial condenser and to the temperature of the vapors leaving said partial condenser to be conducted to said final condenser for controlling the quantity of liquid passed in heat exchange with the vapors in said partial condenser.

In testimony whereof I affix my signature.
DAVID G. BRANDT.

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