

Dec. 6, 1932.

J. H. HILLS

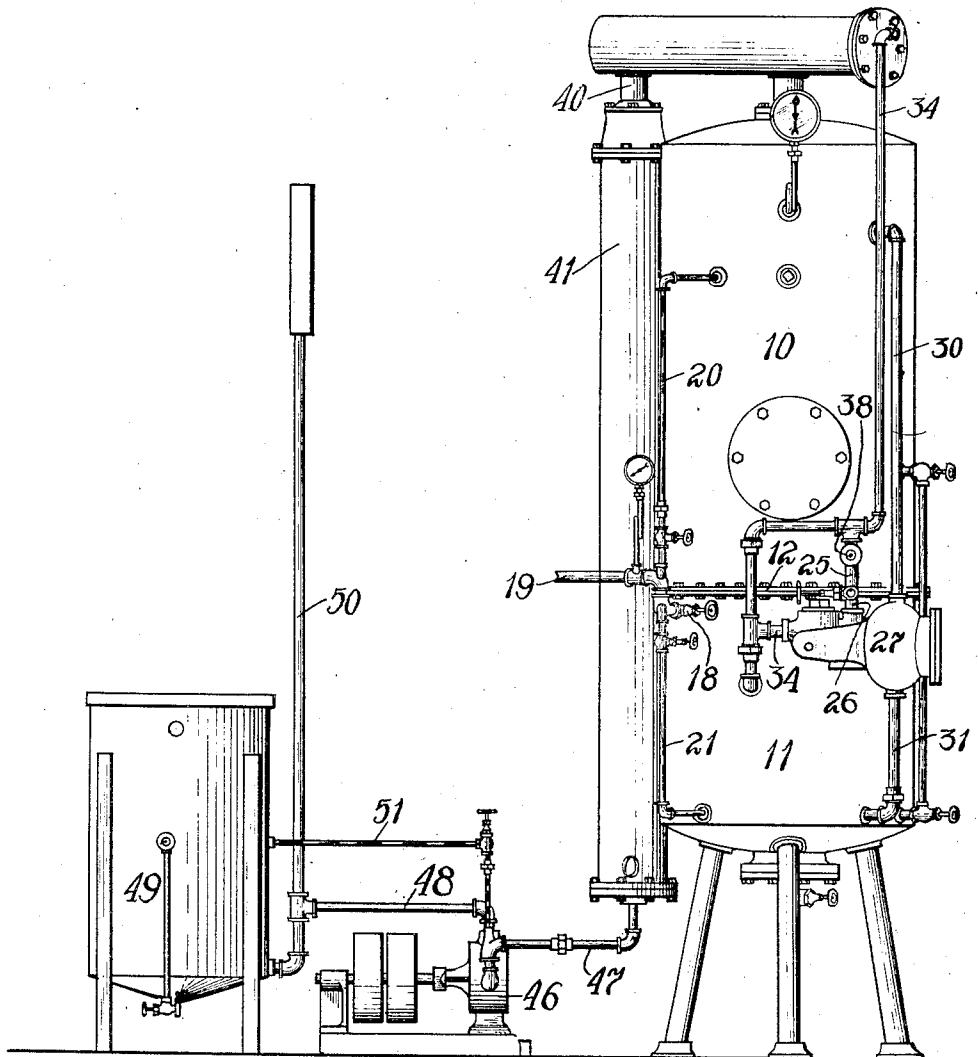
1,890,152

VACUUM STILL

Filed Sept. 20, 1929

3 Sheets-Sheet 1

Fig. 1



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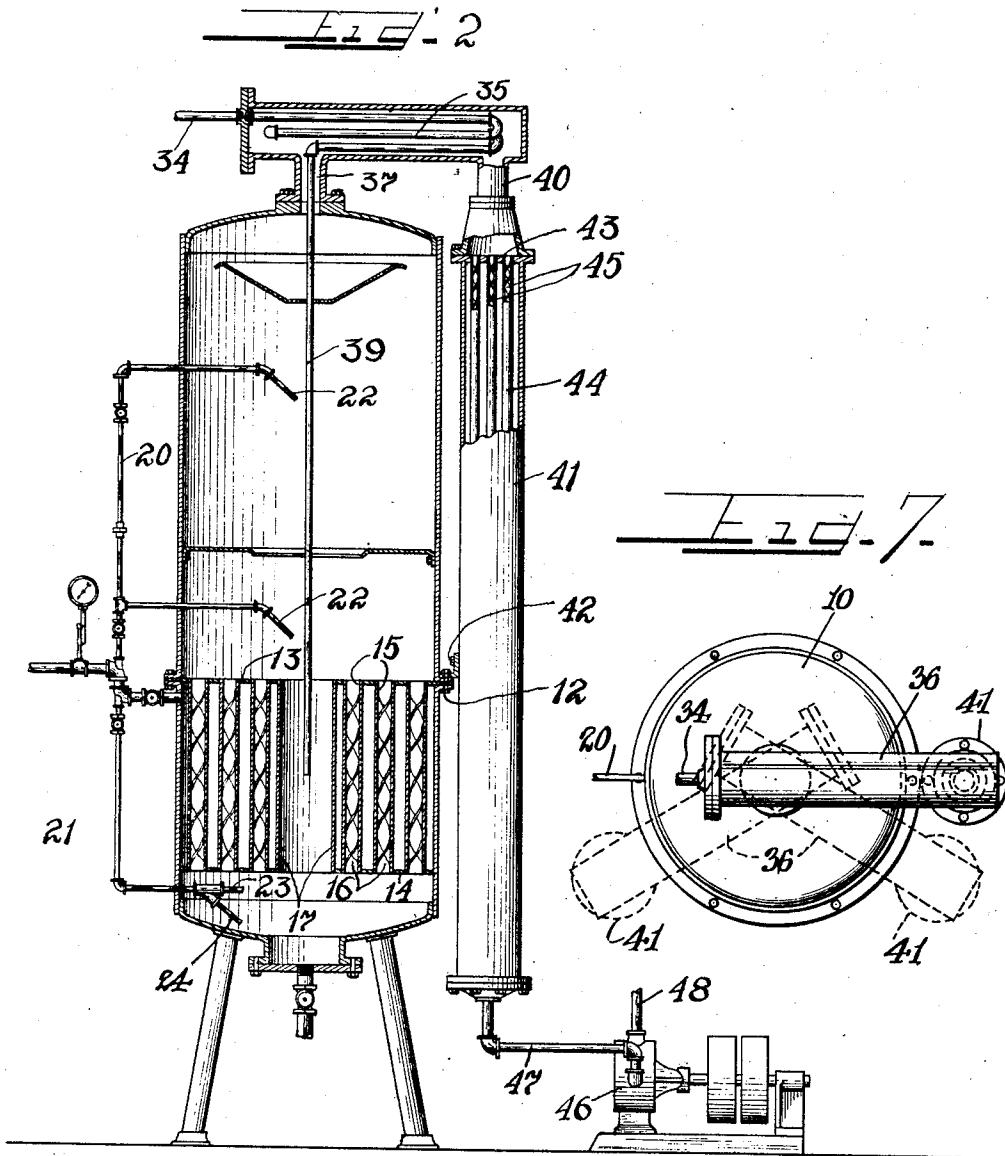
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3 Sheets-Sheet 2



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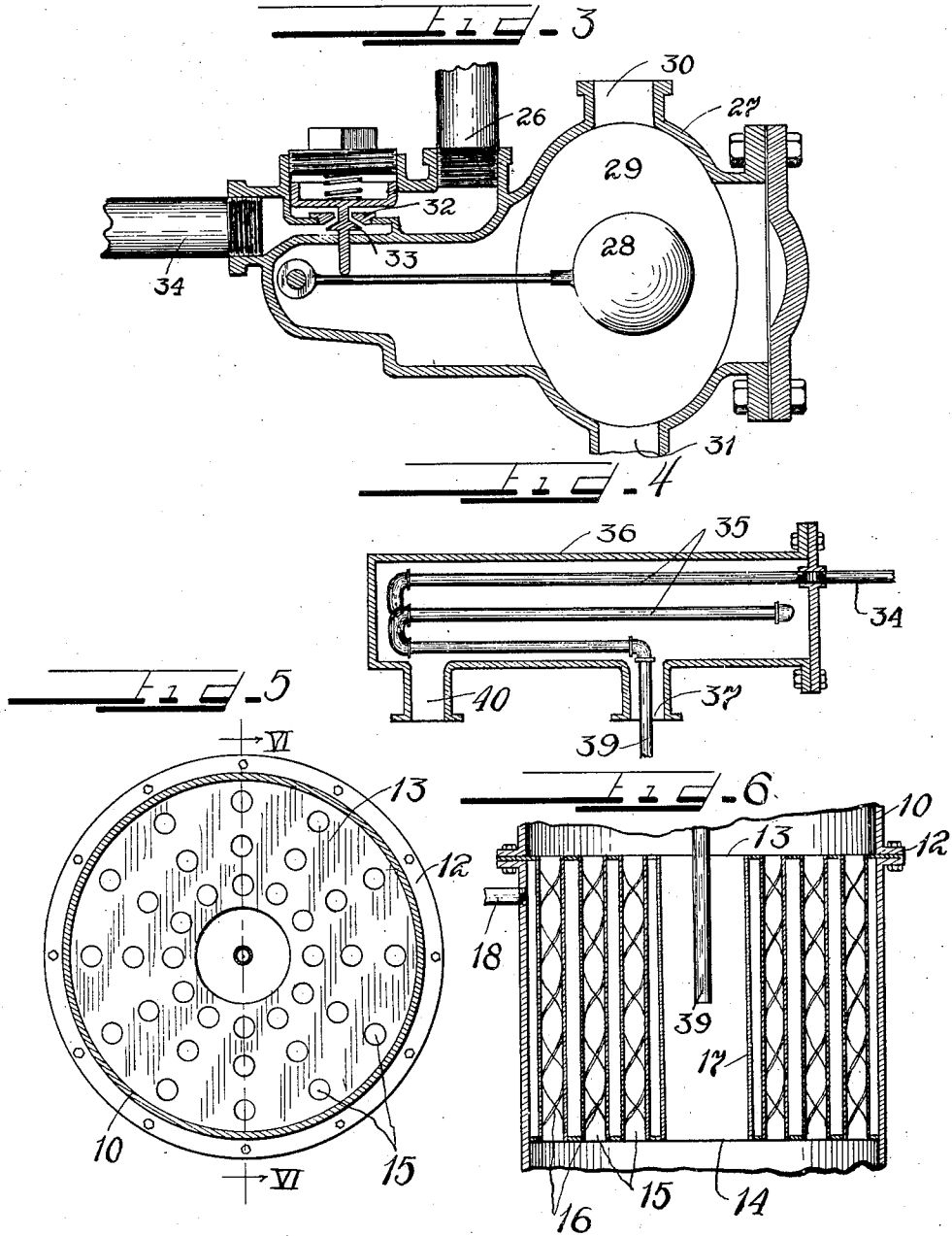
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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VACUUM STILL

Application filed September 20, 1929. Serial No. 393,893.

The invention relates to vacuum stills for reclaiming and purifying volatile liquids.

It is an object of this invention to provide an improved and simplified vacuum still of the class described that will be simple and automatic in use and capable of continuous self-feeding operation without close attendance. In order to accomplish this result a normal operating vacuum in the still is utilized to draw in fresh charges of the liquid as required by variations in the liquid level in the vaporizing chamber and the fresh charge is passed through a preheater or heat exchanger installed in the vapor discharge line from said chamber in order to utilize a portion of the latent and sensible heat of the vapor before it is condensed.

It is another object of this invention to provide an improved heating system for the vaporizing chamber comprising a steam calandria for supplying dry heat to the liquid in said chamber, together with a steam siphon jet acting both to increase the vapor pressure of and to agitate the contents of said chamber.

It is also an important object of this invention to provide an evacuating jet for starting up the still quickly by expelling the air from the chamber and displacing it with steam which is rapidly condensed in the condenser creating a vacuum in much less time than would be required were the vacuum pump depended upon to do the whole work of exhausting the air from the still and condenser.

It is a further object of this invention to provide an improved feed regulator incorporating a bypass adapted to permit manual regulation of the fluid level in the vaporizing chamber when desired.

It is still another object of this invention to provide an improved condenser and preheater mounting and arrangement that will permit changing the position of the condenser relative to the still to suit various installations without requiring alteration of the vapor discharge line from said chamber to the preheater and condenser.

Other and further important objects of this invention will be apparent from the dis-

losures in the specification and the accompanying drawings.

This invention (in a preferred form) is illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is an elevation of a vacuum still system embodying the features of this invention.

Figure 2 is a central vertical section thereof.

Figure 3 is an enlarged detail section of the feed regulator.

Figure 4 is an enlarged detail section through the vapor discharge line with the preheater in elevation.

Figure 5 is an enlarged horizontal section through the vaporizer chamber above the calandria.

Figure 6 is a fragmentary vertical section on the line VI—VI of Figure 5 showing the inlet pipe from the preheater in elevation.

Figure 7 is a fragmentary plan view of the still showing the adjustable mounting of the condenser relative thereto.

As shown on the drawings:

The vaporizer chamber proper comprises a cylindrical vessel formed of top and bottom sections 10 and 11, the abutting edges of the sections being flanged as at 12 and bolted together. The joint so formed also receives the upper tube sheet 13 of a calandria, the lower tube sheet 14 thereof being welded or otherwise secured near the bottom of the lower shell section 11. These two tube sheets are connected by a number of tubes communicating therethrough and containing spiral deflecting strips 16 which assure a more intimate contact of the liquid with the tube walls. Within the calandria a large central tube 17 is provided which permits a central downward flow of liquid balancing the upward flow through the tubes 15 so that a constant circulation of liquid is thus obtained. The space within the calandria surrounding the tubes and between the tube sheets forms an annular steam drum submerged or partly submerged in the liquid to be distilled.

This steam drum or calandria is supplied with steam through a valved inlet 18 from

a steam supply line 19, branches 20 and 21 from this line serving evacuating jets 22 in the upper part of the still, and an agitating jet 23 below the calandria, which latter jet is in the form of an ejector or siphon jet drawing liquid through a pipe 24 from the bottom of the vaporizer and discharging the steam and liquid into the body of the liquid in the vaporizer beneath the calandria to agitate as well as heat the liquid, a small admission of steam at the jet having a high heating value upon starting up because of the latent heat released by the condensation of the steam. The evacuating jet 22 is provided to assist in establishing the initial vacuum when starting up, as by introducing steam at this point until the air has been driven out of vaporizer and the subsequent condensation of the steam rapidly creates approximately the required operating vacuum.

A raw liquid supply line 25 leads to an inlet connection 26 on a feed regulator body 27 containing a float 28 operating in a chamber 29 which is connected with the vaporizing chamber above and below the liquid level therein by equalizing pipes 30 and 31. The inlet connection 26 leads to a valve 33 which is lifted to its seat by the upward movement of the float in the chamber 29. An outlet connection 34 takes raw liquid from below the valve 32 of the feeder and delivers it to preheating coils 35 located in a vapor conductor casing or come over 36 mounted above the central vapor outlet 37 from the vaporizer. Valved bypass 38 is also provided connecting the feed regulator inlet and outlet connections 26 and 34, in order that the feed regulator may be supplemented if desired, by a manually controlled feed. The preheater coils 35 have an outlet pipe 39 extending down through the vapor outlet 37 from the vaporizer to a position below the liquid level in the central calandria tube 17.

The vapor conductor casing 36 is formed as a direct bridge and connection between the vaporizer outlet 37 and an inlet connection 40 to a condenser shell 41 which is supported by lugs 42 from the flange 12 of the vaporizer. With this arrangement the condenser can be mounted in any position relative to the front of the vaporizer, as required by the space available for the device, and a change in the position thereof involves only a change in the direction of the feed piping 34, something well within the ability of an average mechanic. The condenser casing contains top and bottom tube sheets 43 connected by tubes 44 through which the vapor is drawn, these tubes having spiral strips 45 therein resembling the strips 16. The casing has suitable working water inlet and outlet connections, one of which is indicated at the bottom of the condenser in Figure 1.

A vacuum pump 46 is connected by a pipe

47 to the bottom of the condenser below the lower tube sheet to draw off condensate as well as air and water, if present. Said pump discharges through a pipe 48 into a moisture separating and filtering tank 49. The pipe 48 is provided with a vent 50 for discharging uncondensed vapor or air, preferably outside the building housing the still. A priming line 51 is provided leading from the moisture filter 49 to the suction side of the pump to assist in sealing and priming the pump.

In the operation of a device embodying this invention the creation and maintenance of a proper vacuum results in a marked economy of steam and condensing water since the boiling temperature of the liquids usually distilled is lowered between 100 and 150 degrees Fahrenheit by distillation under a vacuum of 25 to 27 inches of mercury. The vacuum pump is chosen of a size sufficient to maintain such a vacuum under the maximum output conditions and is supplemented for initial starting purposes by introducing a steam through the evacuating jet, the steam driving out the air and being itself condensed to help form the initial vacuum quickly. The use of the evacuating jet reduces the size of the vacuum pump required and also results in the establishment of proper operating conditions in a fraction of the time that would be required were a much larger pump depended upon to produce the initial vacuum.

The normal degree of vacuum is sufficient to draw in the raw liquid, even from a distance or from an underground storage tank if such is used. This results in making the still entirely self-feeding, the feed regulator being provided only to maintain a definite liquid level within the vaporizer. From the feed regulator or through the bypass if open, the raw liquid passes through the preheater coil which is of relatively small pipe intended to maintain a sufficient velocity of flow to prevent deposition of the foreign matter carried by the liquid. The preheater also has a condenser effect on the vapor discharged from the vaporizer and thus results in a double gain in efficiency.

The heating of the vaporizer is accomplished by a combination of the wet and dry methods, the calandria or steam drum furnishing a dry heat and the agitating jet mixing steam with the solvent which steam is condensed and gives up its latent heat of vaporization to the liquid until the vaporizer reaches its normal operating temperature, thus resulting in a rapid rise in temperature when starting from cold. In practice the combined use of the evacuator and agitating jets will permit starting up a cold still in from five to ten minutes, after which the operation of the device is continuous and practically automatic.

It will thus be seen that I have provided an

improved and simplified vacuum distillation apparatus that can be rapidly brought into action and will be continuous and practically automatic in operation.

5 I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than
10 necessitated by the prior art.

I claim as my invention:

1. A vacuum distilling apparatus comprising a vaporizer, a condenser, a vapor outlet casing from the still connected with said condenser to partially support the same in any one of various selective positions about the vaporizer, a raw liquid preheater coil mounted in said vapor outlet, a feed regulator
15 for supplying raw liquid to said preheater, heating means for said vaporizer comprising a steam calandria mounted therein, a steam supply line connected therewith, an evacuator jet also connected with said steam line for initially establishing a vacuum in said still, and an agitating jet also connected to said steam line and positioned beneath said calandria for heating as well as agitating the contents of said still.
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2. A vacuum vaporizer comprising a closed vessel in two sections having a bolted joint, a steam calandria built into the lower of said sections and having a large central passage, means for introducing raw liquid into said central passage from above and a preheater located in heat exchange relationship with said means and positioned within the vapor outlet conduit leading from said vaporizer.
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3. A vacuum vaporizer comprising a closed vessel in two sections having a bolted joint, a steam calandria built into the lower of said sections and having a large central passage surrounded by smaller tubes containing spiral deflection strips, and means for maintaining a liquid level in said vaporizer partially submerging said calandria.
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4. A vacuum vaporizer comprising a closed vessel in two sections having a bolted joint, a steam calandria built into the lower of said sections and having a large central passage, surrounded by smaller tubes containing spiral deflecting strips, means for maintaining a liquid level in said vaporizer partially submerging said calandria, and means for introducing fresh liquid into the central passage of said calandria.
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5. A vacuum distillation apparatus comprising a closed vaporizer, means for heating the same, a condenser mountable in various positions upon the sides of the vaporizer, a vapor outlet casing connecting the vaporizer to the condenser, said casing being mountable in various positions on the vaporizer to correspond with the chosen position of the condenser, a raw liquid feed supply including
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preheater coils in said vapor outlet casing and means for controlling said feed supply to a constant fluid level in said vaporizer.

6. A vacuum distillation apparatus comprising a closed vaporizer, a steam injector and dry steam heating means for heating the same, a condenser mountable in any of various positions upon the sides of the vaporizer, a vapor outlet casing connecting the vaporizer to the condenser, said casing being mountable in various positions on the vaporizer to correspond with the position of the condenser, a raw liquid feed supply including preheater coils in said vapor outlet casing and means for controlling said feed supply to obtain a constant fluid level in said vaporizer.
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7. A vacuum distillation apparatus comprising a closed vaporizer, a steam calandria for heating the same, a steam evacuator jet for initially creating a vacuum in said vaporizer, a condenser mountable in various positions upon the sides of the vaporizer, a vapor outlet casing connecting the vaporizer to the condenser, said casing being mountable in various positions on the vaporizer to correspond with the selected position of the condenser, a raw liquid feed supply including preheater coils in said vapor outlet casing and means for controlling said feed supply to maintain a constant fluid level in said vaporizer.
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8. A vacuum distillation apparatus comprising a closed still, means for heating the same, a steam evacuator jet for initially creating a vacuum in said still, a condenser mountable in various positions upon the side of the still, a vapor outlet casing connecting the still to the condenser, said casing being mountable in various positions on the still to correspond with the closer position of the condenser, a raw liquid feed supply including preheater coils in said vapor outlet casing and means for controlling said feed supply to a constant fluid level in said still.
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9. In a distilling apparatus a cylindrical vaporizer having a central outlet, a condenser mountable in various positions on the sides of said vaporizer, a vapor outlet casing connecting the central outlet of the vaporizer to the condenser and partially supporting the latter, a raw liquid feed supply including preheater coils in said vapor outlet casing and means for controlling said feed supply to maintain a constant fluid level in said vaporizer.
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10. In a distilling apparatus a cylindrical vaporizer, heating means for said vaporizer, a condenser mountable in various positions on the sides of said vaporizer, a vapor outlet casing connecting the central outlet of the vaporizer to the condenser and partially supporting the latter, a raw liquid feed supply including preheater coils in said vapor outlet casing and means between the preheater
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and raw liquid supply for controlling said feed supply to a constant fluid level in said vaporizer.

11. In a distilling apparatus a cylindrical vaporizer, a steam evacuator jet for initially creating a vacuum in said vaporizer, a condenser mountable in various positions on the sides of said vaporizer, a vapor outlet casing connecting the central outlet of the still to the condenser and partially supporting the latter, a raw liquid feed supply including preheater coils in said vapor outlet casing and means exterior to the apparatus for controlling said feed supply to a constant fluid level in said vaporizer.

12. In a distilling apparatus a cylindrical vaporizer, heating means for said vaporizer, a steam evacuator jet for initially creating a vacuum in said vaporizer, a condenser mountable in various positions on the sides of said vaporizer, a vapor outlet casing connecting the central outlet of the vaporizer to the condenser and partially supporting the latter, a raw liquid feed supply including preheater coils in said vapor outlet casing and means for controlling said feed supply to obtain a constant fluid level in said vaporizer.

13. A vacuum vaporizer comprising a closed vessel, a steam calandria therein for heating the same and comprising a series of tubes arranged about a relatively large central passage, said tubes containing spiral deflecting strips, a feed regulator for a raw liquid supply to the vaporizer, a preheater receiving the liquid from said regulator, and a discharge pipe from said preheater extending into the central passage of said calandria.

In testimony whereof I have hereunto subscribed my name at Chicago, Cook County, Illinois.

JOHN H. HILLS.

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