

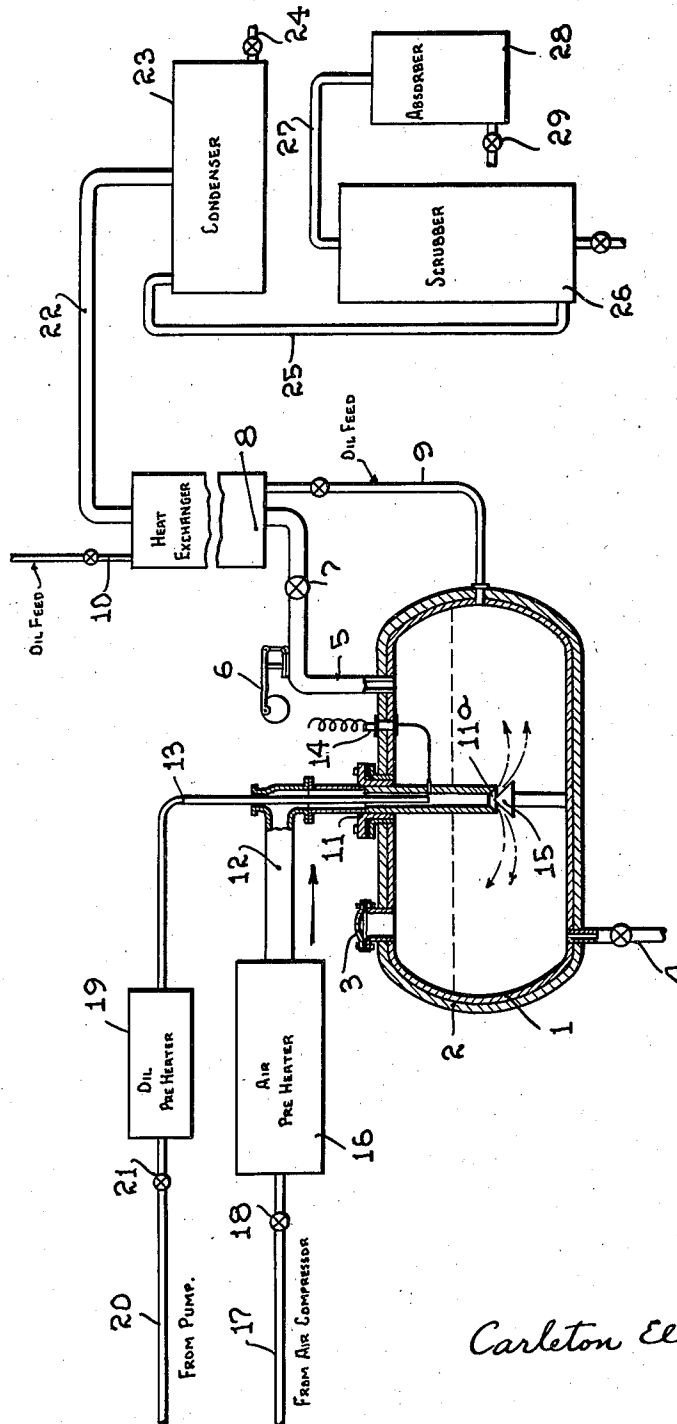
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SUBMERGED COMBUSTION PROCESS

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SUBMERGED COMBUSTION PROCESS.

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This invention relates to a process of heating or distilling or concentrating liquids and to apparatus therefor and relates especially to a method of heating by internal combustion following the theme of my copending application, Serial No. 523,209, filed December 1, 1921.

The invention may be applied to boiling water and steam raising for power or heating purposes, concentration of for example saline solutions and to the distillation of crude petroleum oil to separate gasoline, kerosene and the like or for cracking petroleum oils, tars, pitches, asphalt and similar raw material to make motor fuel and other products. In some cases the invention may be used for stripping an oil to remove gasoline and kerosene and subsequently cracking the residues.

The present invention will be illustrated by the application to the cracking of petroleum oil but as is evident from the foregoing the invention is not limited to such means of exemplification.

For this purpose the gas oil or other heavy oil to be cracked is placed in a horizontal or vertical still and into the oil is forced an inflammable oxygen-containing mixture capable when ignited of burning beneath the surface of the oil yielding a submerged flame or plurality of flames or reaction zones, imparting heat readily to the adjacent oil and thus heating it to a cracking temperature.

Preferably the burner flame is protected at least during its ignition and the incipient stages of its formation by contact with walls of fire clay, masses of refractory material and the like. The burner preferably depends from the top of the still into the oil so that the combustible mixture or the flame or hot gases therefrom are forced for a short distance downwardly in the oil subsequently rising and being carried away along with the products of cracking and distillation.

The fuel employed in the burner preferably is an oil which has no especial value for purposes other than as a fuel. Thus I may employ still residues, petroleum tars, coal tars, oils which remain after cracking by

usual pressure still or other processes and which are thus of little value as a further source of gasoline and kerosene. Colloidal fuel and still residues containing suspended carbon also are available. Still gases may be used as the sole fuel or in conjunction with fuels such as those mentioned above.

The invention however does not preclude the use of more valuable fuels.

Preferably the oil which is to be distilled or cracked is preheated which may be accomplished by employing a heat exchanger through which the oil flows before entering the still and which is heated by the outgoing products of distillation passing to the condensers.

As the supporter of combustion I may use ordinary air or air which has been dried or humidified or air enriched by adding oxygen for example up to a content of 35 per cent or thereabouts. The air used preferably is preheated by a suitable fore-warmer, which may be separately fired. A heat exchanger likewise may be used advantageously. When employed under pressure it may be noted that the compression pump heats the air to a degree depending upon the pressure employed and such heated air may be conveyed to the still without cooling and with further heating if desired. There may be some cases of operation when the injection of steam would be desirable and its use is not precluded.

When cracking pitches, asphalts and some still residues of low volatility and high fire point the operation may be carried out in some cases at atmospheric pressure or even at a pressure below atmospheric but I prefer to conduct many operations at superatmospheric pressure. Thus treating oils which cannot be cracked without excessive volatilization of undesirable heavy bodies I may use still pressures of 4 to 5 atmospheres, or sometimes 6 to 10 atmospheres and for more volatile raw material pressures of 10 to 20 atmospheres or even higher may be utilized. The condensation may take place under such pressures or at reduced pressures down to atmospheric or even lower. For

the removal of some of the most volatile products condensation may be carried out in part at least under pressures higher than that of the still.

5 Submerged combustion tends to be intensified and rendered more positive and certain with increase of pressure and there do not appear to exist the same limitations of pressure that obtain with externally fired
10 (ordinary direct fire) stills. With the latter softening of still bottoms occurs, which is aggravated by the formation of coke on the inside of the shell. With submerged combustion the still shell is relatively cool and
15 may be easily kept below the softening point of steel. Likewise the shell may be heat insulated either on the inside or the outside by suitable lining or jacketing. This however does not preclude the employment of
20 direct external firing along with submerged combustion when such a combination of heating elements is desired.

Submerged combustion tends to eliminate coke troubles as the carbon may be obtained
25 in a colloidal or suspended form which is drawn off with the residual oil and subsequently may be used as a fuel for the still.

Such stills may be operated in batteries if desired in conjunction with a condenser
30 common to all the members of the group or in other ways the stills may be connected and operated to conform with pressure still practice. The stills may be operated by the batch or discontinuous method on the one
35 hand or in a continuous manner by causing oil to flow into the still continuously while withdrawing from a point elsewhere in the still and preferably remote from the location of the oil feed the oil residues, such with-
40 drawal taking place at an appropriate rate to maintain the level of the oil in the still preferably well above the burner orifice.

The still may have means for circulating oil through it for example the oil may be
45 withdrawn from one end of the still through a coil and pumped back into the still at the other end.

In addition to condensation in the usual way the gases or vapors may be washed with
50 water or scrubbed with oil or absorbed by activated charcoal or silica gel or several of these means may be employed with the object of removing to as great an extent as possible from the gases any products of
55 value as a fuel or for other purposes.

It is not the purpose of the present invention to induce combustion of the oil in the still but rather to heat and crack such oil by means of fuel (gaseous, liquid or solid,
60 or mixtures of two or more of these) separately introduced into the still from extraneous sources, along with sufficient air or oxygen for fairly complete combustion of such extraneous fuel. As near the exact
65 amount of air that will suffice for such com-

plete combustion preferably is used. In this way the charge of oil in the still, which presumably is better adapted for cracking purposes than the low grade oil fuel employed need not be materially altered other than
70 through those changes due to subjection to a cracking temperature.

The invention is illustrated by the appended drawing which shows a still in vertical section with auxiliary equipment in
75 elevation.

In the drawing 1 is a closeable receptacle or still having the heat insulating jacket 2, manhole 3 and draw-off 4. 5 is an outlet pipe for the products of distillation or cracking, which is equipped with a safety valve and with a pressure regulating valve 7. 8 is a heat exchanger through which by means of suitable flues (not shown) the hot products of distillation pass onward to the condenser. Raw oil which is being fed to the still through the pipe 9 first passes through the heat exchanger and becomes preheated. 11 and 11^a designate a burner depending from the roof of the still. This burner is supplied with air through the pipe 12 and with oil or other fuel by the pipe 13, the latter being concentrically within the air pipe. 14 is an electrical igniting apparatus, one terminal of which is located in the burner and the other is connected to the still at any suitable point. This provides a means of creating a spark in the burner to bring about ignition. The lower end of the burner projecting into the oil is preferably tapered or bevelled from inside to the exterior and a baffle cone of refractory material 15 is placed axially beneath the burner pipe in order to facilitate combustion. The burner pipe at least in its lower part is lined with refractory material. 16 is an air-preheater, 17 is the air-supply pipe from the air compressor (not shown) and 18 is a valve to control the flow of air. 19 is an oil pre-heater to which oil from a suitable force
80 pump is supplied through the pipe 20; regulation being obtained by the valve 21. The oil flowing through the preheater passes down the pipe 13 into the burner. During the starting up operation later described it is sometimes desirable to use still gas in place of oil and this fuel can be supplied through the same pipe. 22 is a conduit connecting the heat exchanger with the condenser 23. 24 is a valve-draw-off to remove the products
85 of condensation. The uncondensed material passes through the pipe 25 to the scrubber 26 and thence by the pipe 27 to the absorber 28.

Example.—Assuming the operation is carried out at a petroleum refinery, force a mixture of pressure still gas with air sufficient for combustion, at a high velocity through the burner 11, igniting the mixture by an electric spark. Allow the products of com-
90 130

bustion to escape through the manhole 3. When the burner becomes heated to the fuel-oil fire-point temperature atomize fuel oil into the burner in lieu of still gas proportioning the air for complete combustion without excess. The entering air should be preheated to about 400° F. Close the manhole and charge the still with gas oil preheated to 500° F. introducing a sufficient quantity to submerge the burner and preferably filling the still to about two-thirds its capacity. A pressure may then be created in the still either by employing gases from an adjacent pressure still or by allowing the pressure to build up spontaneously in the still by adjusting the valve on the outlet or condenser side of the still. Create in this manner a pressure of approximately 15 atmospheres and maintain the temperature by adjusting the amount of fuel and air mixture so that the oil in the still is approximately 800° F. By means of the condenser a large proportion of the oily products carried over from the still will be condensed. Absorption of further quantities will take place in the scrubber 26 or in the silica gel or charcoal absorption chamber 28. From the latter the absorbed material may be recovered in the usual way. The products from the condenser likewise may be refined by customary procedures. The scrubber liquid is distilled to collect volatile bodies.

What I claim is:—

1. The process of heating and distilling a liquid which comprises injecting an ignited preheated fuel admixed with air to support combustion downwardly beneath the surface of said liquid.

2. The process of heating and distilling a liquid which comprises injecting an ignited fuel admixed with preheated air to support combustion beneath the surface of said liquid.

3. The process of heating and distilling a liquid which comprises injecting an ignited preheated fuel admixed with air to support combustion beneath the surface of said liquid the latter being under superatmospheric pressure.

4. The process of cracking heavy oil which comprises forcing an ignited fuel mixture comprising liquid fuel and air beneath the surface of a body of oil under pressure; whereby the latter is heated to a cracking temperature.

5. The process of cracking heavy oil which comprises forcing an ignited fuel mixture comprising liquid fuel and air, both preheated, beneath the surface of a body of oil under pressure; whereby the latter is heated to a cracking temperature.

6. The process of heating and distilling a liquid which comprises injecting an ignited fuel admixed with air to support combustion downwardly beneath the surface of said

liquid, withdrawing products of distillation, and preheating the liquid undergoing treatment with such products of distillation.

7. The process of treating heavy oil which comprises injecting an ignited fuel mixture admixed with air beneath the surface of a body of heavy oil, withdrawing products of distillation, and preheating the heavy oil undergoing treatment with such products of distillation.

8. The process of treating heavy oil which comprises injecting an ignited fuel admixed with air beneath the surface of a body of heavy oil, the latter being under a pressure of from 4 to 20 atmospheres.

9. The process of treating heavy oil which comprises injecting an ignited fuel admixed with air beneath the surface of a body of oil whereby products of distillation and residual products are formed, withdrawing the residual products and utilizing them as fuel for treating more oil.

10. The process of treating heavy oil and related substances which comprises forcing an ignited fuel admixed with air beneath the surface of a body of heavy oil, continuously supplying oil to be treated to the body of heavy oil, and continuously removing treated oil from said body of oil, in order to maintain the body of oil at substantially constant level.

11. The process of heating and distilling a pool of heavy oil which comprises injecting an ignited mixture of fuel and air into a pool of heavy oil whereby the fuel is burned within the pool of oil.

12. The process of treating a pool of hydrocarbon oil which comprises distilling said oil by heat generated from the combustion of a hydrocarbon fuel within the pool of oil.

13. The process of treating a pool of hydrocarbon oil which comprises cracking said oil under pressure by heat generated from the combustion of a hydrocarbon fuel within the pool of oil.

14. The process of treating a pool of hydrocarbon oil which comprises treating said oil by heat generated from the combustion of a fuel by air within the pool of oil, the amount of air being sufficient for substantially complete combustion of the fuel.

15. In the treatment of hydrocarbon oil to distill the same by injecting a fuel-air mixture into a pool of such oil, the step of igniting said fuel-air mixture by a spark within the pool of oil.

16. In the treatment of hydrocarbon oils by internal combustion, the step of introducing a gas containing a greater proportion of oxygen than does ordinary air into a pool of oil under conditions of internal combustion.

17. A process of cracking hydrocarbon oils which comprises maintaining a pool of oil, introducing an oxygen containing gas and

readily volatile hydrocarbon within a submerged portion of said pool of oil, igniting said volatile hydrocarbon within said portion of the oil, discontinuing the supply of
5 readily volatile hydrocarbon and supplying another fuel to maintain combustion. which comprises maintaining a pool of oil, initiating combustion within a submerged portion only of such oil, and maintaining such combustion within a submerged portion only, of the pool.

18. A process of treating hydrocarbon oils

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