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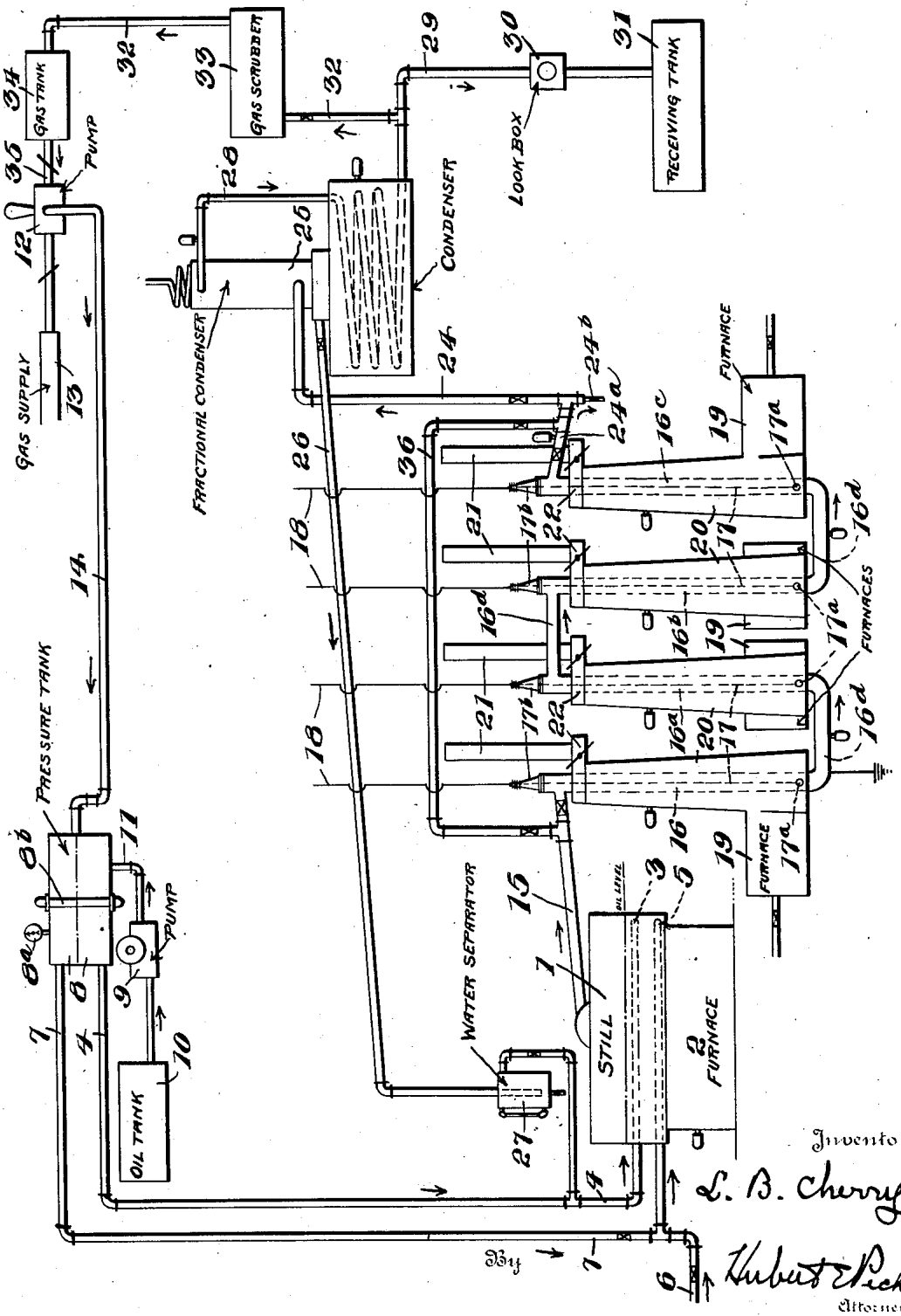

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UNITED STATES PATENT OFFICE

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PLANT FOR THE TREATMENT OF HYDROCARBONS

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This invention relates to certain improvements in plants for the treatment of hydrocarbons and other compounds; that the objects and nature of the invention will be readily understood by those skilled in the art in the light of the following explanation of the accompanying drawings illustrating what I now believe to be the preferred mechanical expression or embodiment of my invention from among other forms, constructions, arrangements and combinations within the spirit and scope thereof.

An object of the invention is to improve apparatus used in the production of low boiling-point hydrocarbons from relatively heavy oils and distillates, with the end in view of increasing the conversion percentage, in other words, to increase to the maximum the percentage of yield of low boiling-point hydrocarbons and to reduce to the minimum the percentage of waste or loss in the conversion process.

With these and other objects in view, my invention consists in certain novel features in construction, arrangements, and in combinations as more fully and particularly set forth and specified hereinafter.

Referring to the accompanying drawings:

The single view diagrammatically illustrates apparatus embodying my invention for the practice of my method.

In the drawings I diagrammatically illustrate any suitable still 1, heated in any suitable manner or by any suitable means. In the particular example illustrated, I indicate a low pressure horizontal still heated by furnace 2. The heavy oil, distillate or other hydrocarbon to be converted into low boiling-point hydrocarbon, gasoline or the like, is introduced into the still through the medium of pipe lengths or coils 3 arranged in the still below the oil level therein and approximately throughout their lengths having bottom oil outlets or discharge openings in the form of perforations through the under sides of the pipe lengths or coils. The oil (product to be converted) flowing into the still through the coils 3 is thus discharged downwardly into the hot liquid in the still in the form of small streams or jets distributed throughout the body of liquid in the still. The entering oil while in the coil 3 is subjected to the temperature of the still and is approximately brought to the temperature of the liquid within the still, before such oil is directly discharged into the still. Certain advantages are gained by this arrangement, and particularly any moisture or water that might be present in said oil will be vaporized before such oil is sprayed or discharged into the liquid in the still.

The oil supply to the perforated coil 3, is maintained through supply pipe 4.

Within the still, usually in the lower part thereof, I provide a pipe 5 for delivering natural or other gas, steam, or a combination of steam and gas, into the liquid in the still. This pipe 5, is usually arranged longitudinally of the still and is perforated to jet and distribute the gas and steam into the body of liquid.

The discharge pipe 5, is supplied with steam through steam supply pipe 6 from any suitable source, or with gas through gas supply pipe 7 from any suitable supply, suitable valves and cut-offs being provided to control the flow and to cut off either the gas or steam or both.

In the example illustrated, the gas and oil are delivered to the still under pressure, from a pressure tank 8 into which the oil and gas are both forced under pressure. The oil offtake pipe 4 opens into tank 8, below the liquid level therein, while the gas offtake pipe 7 opens into said tank above the liquid level therein. The gas and oil pressures are equalized in said tank, and said tank is usually provided with a pressure gage 8^a and an oil level indicating glass or other indicator 8^b.

Pressure is maintained in said gas and oil pressure equalizing tank by pumps utilized to force the oil and the gas into said tank. For instance, I show pump 9 for forcing the oil from any suitable crude or other oil supply 10, through pipe 11 into the tank 8; and gas pump 12 for forcing the gas from any suitable gas source or supply 13, through pipe 14 into said tank 8.

The still is maintained at the desired tem-

perature to vaporize the heavy oil, and the vapor and gas mixture passes from the still to and through one or more vertical reaction tubes wherein the vaporous product from the still is subjected to the cracking or dissociating energy given off by red hot walls of the reaction tubes and at the same time is excited by high frequency oscillatory electrical discharges, all for the purpose of changing the molecular structures of the hydrocarbon vapors and gas to produce low boiling point hydrocarbons suitable as motor fuel and other uses.

In the particular example illustrated, I show a reaction conduit embodying four reaction tubes 16, 16ª, 16ᵇ, 16ᶜ, connected in series by any suitable cross conduits or ducts 16ᵈ so that the passage through the conduit is continuous, i. e. the passage is continuous throughout the length of each tube and from tube to tube in succession. The products pass from the top of the still through offtake pipe 15 into the upper end of tube 16 and through the tubes 16, 16ª, 16ᵇ, 16ᶜ, in succession, passing down through some of the tubes and up through the remaining tubes. The tubes are composed of suitable metal to form electrodes that are suitably grounded. Within each tube the opposing electrode 17 is centrally and longitudinally arranged to provide an annular gap within the tube and around electrode 17. The electrodes 17 are preferably formed by wires having porcelain or other insulating weights or plummets 17ª at their lower ends, and hung at their upper ends from insulators 17ᵇ. These electrodes 17 are electrically connected, as through connections 18, with any suitable sources of oscillatory high frequency electrical energy to produce silent high frequency discharges in each reaction tube traversing the vaporous mixture therein and flowing back and forth between the tube walls and wires. I produce a discharge of such high frequency and character as to approximately fill and maintain in each tube a violet glow during the continuance of the electrical treatment and that will check the cracking effect of the heat to prevent substantial carbon deposit.

Each reaction tube, in this embodiment, is individually heated by independent heating means, for instance, an independent heating furnace 19 and heating flue 20. The several heating flues have top discharge outlets 21 controlled by dampers 22. Each flue outlet is controlled by its own damper so that the draft through each flue can be independently controlled.

Each vertical reaction tube is surrounded approximately throughout its length by its heating flue while the furnaces open into the lower ends of the flues. In the example illustrated, I show natural or other gas furnaces, each being separately and independently controlled whereby the heat of each reaction tube can be independently controlled and varied. The heating furnaces and their flues are designed and arranged to maintain each reaction tube, or portions of the tubes, at approximately a red heat, to maintain approximately a "cracking" temperature in each tube, where so desired or required, as more fully set forth hereinafter.

The vapor offtake pipe 15 from the still is preferably arranged to drain back into the still to prevent passage into the reaction conduit of any possible condensation in said pipe. Any suitable vapor offtake pipe 24 is provided to carry off the gaseous (vapor) products from the rear or outlet end of the reaction conduit, and deliver the same to a suitable condenser. This offtake 24 is provided with any suitable check and controlling valves, if deemed advisable. Also, the intake end portion 24ª of said pipe is inclined to drain away from the outlet end of the reaction conduit. This inclined portion 24ª is preferably arranged to cause any condensed products to drain to a trap or discharge tap 24ᵇ.

The vapor offtake pipe 24 delivers the hot gaseous products from the still and reaction conduit into a fractional condenser 25 wherein the so-called "heavy ends" or high boiling point products are first condensed by a reflux condenser and returned to the still by gravity through return pipe 26 and water separator 27 into the crude oil supply pipe 4, suitable check and controlling valves being provided. The remaining hot although somewhat cooled vapors then pass through pipe 28 to the final cooling coils of the condenser, wherein the final low boiling point liquid product, whether so-called gasoline or other hydrocarbon product, is delivered by gravity, through pipe 29, and "look box" 30, into any suitable storage or other receptacle 31, and the non-condensible gases from the fractional condenser, pass off through pipe 32, which is suitably valved, and gas scrubber 33 into gas holder 34. This gas is drawn from holder 34 by gas pump 12 through suitably-valved suction pipe 35 and delivered through pipe 14 into pressure tank 8 for return to the still.

The so-called "look box" is arranged to permit the operator to visually examine the final liquid hydrocarbon product, as to color and other characteristics, and thereby determine whether to vary the electrical discharge in the reaction conduit or vary the temperature in any one or all of the reaction tubes, or make other adjustments to change temperature conditions in the fractional condenser or other conditions in the still.

I also provide a by-pass pipe or conduit 36 from the vapor offtake pipe 15 from the still to the hot gaseous product offtake pipe 24 from the reaction conduit, and suitable valves, so that in case of need, the reaction

conduit can be cut out of the circuit without stopping the operation of the still. In other words, the hot gaseous products from the still will, should the reaction conduit be cut out, be conducted through pipes 15, 36, and 24, direct to the fractional condenser, and the operation of the plant can continue, although at greatly reduced efficiency in the matter of percentage of conversion, if any, until the reaction conduit is again thrown back into the circuit and brought into proper operation.

If repairs of electrical equipment or of the reaction conduit become necessary or if it is desirable to inspect said conduit or if the electrical power temporarily fails, the by-pass 36 is brought into action.

When the reaction conduit is included in the circuit for the passage of the hot gaseous products from the still, the by-pass is closed against passage of said products.

When the reaction conduit is cut out of the circuit by shunting the hot vapors from the still to the condenser by way of the by-pass, whatever light final product such as gasoline that may be delivered to receptacle 31, will be vaporized from the crude oil or other heavy product in the still and condensed in the fractional condenser; in other words, there will be gasoline or other light final product delivered into receptacle 31 if such product was present in the crude oil or other heavy product in the still.

The still is operated at any suitable temperature and under any suitable conditions, to vaporize the crude oil or other heavy hydrocarbon products to the maximum percentage, and the superheated steam, and natural or any other suitable hydrogen supplying gas, and vaporized hydrocarbons are mixed in the still, and such gaseous products (the vapors and gases) from the still are passed through the reaction conduit and therein subjected to the cracking temperature of the reaction tube walls and to the silent high frequency electrical discharge.

The high frequency electrical discharge and the high temperature bring about such rearrangement of the molecular structures of the vapors and gases as to result in the production of lighter or low boiling point high gravity products of the nature of gasoline, and that without substantial precipitation or deposit of free carbon in the reaction conduit. In other words, heavy low gravity high boiling point crude oils or hydrocarbons are by my apparatus and method converted into products of the nature of gasoline.

Suitable electrical equipment is employed to produce oscillatory waves of sufficiently high voltage and frequency or periodicity to force the required molecular vibrations and consequent required changes in the structures of the highly heated hydrocarbons. The radiant energy thus developed in the reaction conduit by this silent electrical discharge produces what is apparently a violet glow in said conduit, and apparently I gain the best conversion results when such a glow is present in the reaction conduit, according to my observations to the present time.

The conversion results are attained by the action of the high frequency electro-radiant energy on the gases or vapors while at cracking temperature. The temperature in portions of the reaction conduit will run as high as about six hundred to one thousand degrees Fah.

I find that better conversion results are attained by varying the temperatures in different portions of the length of the reaction conduit. For instance, the temperature drops in the cross connections 16^d with respect to the temperature in the tube portions within the heating flues, and the temperature will even vary throughout the length of a heated reaction tube. I gain particular advantages in this matter of reaction tube temperature, by providing the independent furnaces and heating flues. The temperature of each reaction tube can be independently controlled by manipulating the flues and furnace dampers as well as by regulating the fuel supply to the furnace burner. Under some conditions, I get better conversion results by reducing the temperature in one or more reaction tubes compared to the temperature in the remaining reaction tubes, and under other conditions by extinguishing the burner in one or more furnaces while maintaining the high temperature in other furnaces and their flues, while under other conditions by maintaining approximately uniform high temperatures in all of the reaction tubes.

At present, these varying conditions are not always known or appreciated, and hence when the results drop below what is desired, the electrical apparatus is adjusted until the conversion result is satisfactory, or the independent heating means of one or more reaction tubes are manipulated until the conversion result sought is attained.

It is evident that various changes, modifications, and departures might be resorted to without departing from the spirit and scope of my invention and hence I do not wish to limit myself to the exact disclosures hereof.

What I claim is:

1. Apparatus for converting heavy hydrocarbons into different boiling point hydrocarbons, comprising a still; a reaction conduit receiving the gaseous products from the still; a fractional condenser receiving said products from the conduit; a combined gas and heavy oil pressure tank; means for forcing the uncondensed gases from the con-

denser into said tank; means for forcing heavy oil into said tank; means for delivering heavy oil from said tank and heavy condenser products from said condenser into the still; and means for delivering gas from said tank into the still.

2. Apparatus for the treatment of hydrocarbons comprising a conduit for the passage of hydrocarbon vapors and gases embodying several reaction tubes connected in series; heating flues arranged longitudinally and exteriorly of said tubes, respectively, each flue having means whereby the temperature of the tube therein can be independently controlled with respect to the remaining tubes; and means for maintaining high frequency electric discharges in said tubes.

3. In combination, a still; a reaction conduit receiving the gas and vapor products from the still; means for maintaining high frequency radiant energy waves in said conduit; separate heating flues for successive portions of said conduit, whereby the temperature of said successive portions can be independently varied and controlled; and a condenser receiving said products from said conduit.

4. In combination, a still; a condenser; a pipe line for the gas and vapor products from the still to the condenser, said line embodying several reaction tubes and cross connections connecting said tubes in series, means for maintaining electrical discharges in said tubes, and heating furnaces having heating flues arranged exteriorly and longitudinally of said tubes, said furnaces and flues being separately and independently controllable.

5. In combination; a still; a fractional condenser; a conduit for conveying gaseous and vaporous products from the still to the condenser; a pressure equalizing tank; means for forcing oil thereinto; means for discharging oil from said tank into the still; means for discharging condensed products from the condenser into the still; means for forcing gaseous products discharged from the condenser into said tank, and means for discharging gaseous products from said tank into the still.

6. In combination; a still; a fractional condenser; a reaction conduit; means for heating portions thereof; means for maintaining electric discharges in said conduit; a pipe for conveying gaseous and vaporous products from the still to the conduit; a pipe for conveying gaseous and vaporous products from the conduit to the condenser and having a portion to prevent drainage back to the conduit; a by-pass connecting said pipes to cut out the conduit; and valve means for directing the gaseous and vaporous product flow through either the by-pass or the conduit.

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