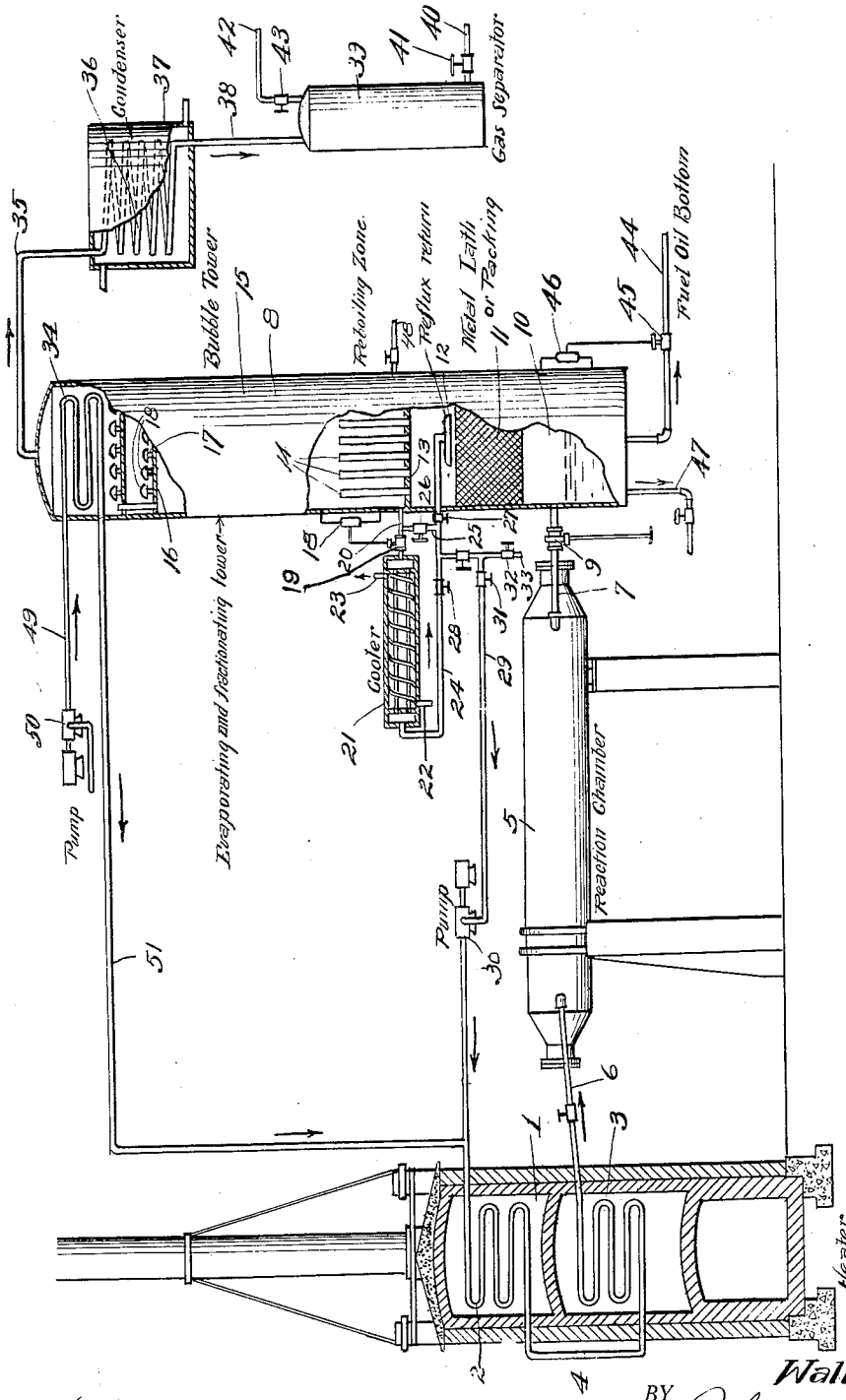
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APPARATUS FOR CONVERTING PETROLEUM HYDROCARBONS

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APPARATUS FOR CONVERTING PETROLEUM HYDROCARBONS

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This invention relates to improvements in a process and apparatus for converting petroleum hydrocarbons, and refers more particularly to a process in which relatively high boiling point oils are converted to oils of a lower boiling point, such as motor fuels having the characteristics of gasoline and the like.

Among the advantages of this construction are, to provide a process in which the oil is maintained at cracking conditions of temperature and pressure until a substantial portion of the oil has been converted, producing a synthetic crude or crude equivalent having a considerable portion thereof comprising low boiling point hydrocarbons; to provide a process in which this synthetic crude, while in a highly heated condition, is introduced to an evaporating stage at a reduced pressure at which time the lighter fractions in the oil evaporate off in the form of vapors which are fractionated and finally condensed to produce a gasoline distillate while the reflux condensate is returned and reboiled or redistilled by utilization of the heat of the hotter vapors in the evaporating stage; to provide an apparatus for carrying out the process hereinafter described in more detail.

The single figure is a side elevational view with parts in section and parts broken away.

Referring to the drawing, at 1 is shown a furnace in the upper compartment of which are positioned preheating tubes 2, while in the lower compartment are the heating tubes 3. The tubes in the separate compartments are connected up by line 4 to produce a continuous passage of the oil through the heating stage. At 5 is shown a reaction chamber heavily insulated to prevent loss of heat by radiation. This reaction chamber is preferably forged from a single ingot of steel to produce a receptacle or chamber adapted to withstand high pressures at high temperatures. The chamber has removable end openings by means of which it may be cleaned from time to time of deposited carbon which accumulates during the conversion or cracking of the oil. The chamber 5 is connected by means of a transfer line 6 to the discharge end of the heating tubes 3 and similarly, by means of a transfer line 7, to the tower 8. A reduction valve 9 is interposed in the transfer line 7.

The tower consists of a lower evaporating zone 10 in the upper portion of which is positioned a layer or zone of dispersing material 11, such as metal lath, Raschig rings or other broken up ceramic material inert to the action of the hydrocarbon vapors. Just above this dispersing zone through which the vapors must pass as they rise upwardly through the tower is a spray pipe 12 through which the condensate is returned from the upper fractionating stage to the lower evaporating stage for redistillation. The tower is divided centrally by means of a horizontal division plate 13 which is perforated to receive the vertical standpipes 14. The vapors on rising through the tower pass from the evaporating zone through the dispersing zone and through the standpipes 14 to the fractionating stage 15 which consists of a plurality of trays 16 holding bubble risers 17 surmounted by caps 18 as in the usual type of bubble tower construction, the latter serving to reverse the flow of the vapors and cause them to percolate through the pools of oil maintained upon the separate trays. Arranged on the side of the tower, and adjacent the upper ends of the standpipes 14, is a liquid level regulating device 18 which functions to maintain a pool of condensate upon the lower compartment plate 13, keeping the standpipes immersed in oil in order that a portion of the heat of the vapors passing therethrough will be transferred to the liquid pool surrounding the pipes. This liquid level regulating device controls a valve 19 in the drawoff line 20 from this lower pool. The line 20 communicates with a cooler 21 through which the liquid is passed and cooled by being brought into heat exchange relationship with a cooling medium introduced to the shell of the cooler through the line 22 and discharged through the pipe 23. The cool liquid passing from the opposite end of the cooler is directed through the line 24 and is distributed in the dispersing stage of the evaporating stage or on to the metal lath or

broken up packing material 11 in the evaporating stage. A by-pass line 25 controlled by a valve 26 serves to by-pass the cooler if desired. By manipulation of the valves 26 in the by-pass line and valves 27 and 28 in the line 24, the reflux material may be directed through a return line 29 and recycled by means of the pump 30 back through the heating coil or by regulation of the valve 31 in the line 29 and valve 32 in the line 33 the reflux condensate may be drawn from the system.

In the top of the tower is a preheating coil 34. The overhead vapor line 35 communicates with a coil 36 positioned in the condenser box 37,—the discharge end of the cooling coil terminating in a line 38 which leads to a gas separator 39, the latter being equipped with a liquid drawoff line 40 controlled by a valve 41 and a gas relief line 42 controlled by a valve 43. The unvaporized material from the bottom of the tower is withdrawn automatically through the pipe 44 in which is interposed the valve 45 controlled by a liquid level regulating mechanism 46. Steam lines 47 and 48 serve to inject steam into the evaporating and fractionating stages, respectively.

In operation, the oil is introduced from any convenient source through the pipe 49 and charged, by means of a pump 50, through the preheating coil 34 and line 51 to the heating coil 2, thence through the heating coil 3 where it receives its cracking heat prior to being discharged through the transfer line 6 into the reaction chamber 5. The temperatures in the heating and reaction stages range from 550° to 1000° F., while sufficient pressure is maintained upon the cracking stages to maintain the oil substantially in liquid phase, normal operating pressures ranging from 450 to 1500 pounds per square inch. The velocity of circulation of the oil through the heating coil is so controlled that deposition of carbon is substantially eliminated in the heating stage.

The oil discharged from the reaction chamber through the transfer line 7 is introduced at a reduced pressure to the lower or evaporating section of the tower 8. Due to the reduced pressure and the contained heat of the oil, the lighter fractions immediately evaporate off, the vapors being dispersed in the stage 11, containing metal lath or broken up material. This dispersing stage serves to separate out a greater portion of the entrained liquid in the form of oil globules which contaminate the vapors and produce an excessive load upon the fractionating equipment. The vapors, in this stage, also are subjected to a partial refluxing action due to the introduction of relatively cooler reflux condensate with which the vapors are brought into intimate contact. Passing from the evaporating stage, the vapors rise through the standpipes 14 and pass thence through the series of evaporating pools in the bubble tower portion of the tower. In their passage through these pools, the higher boiling fractions are separated out in the form of condensate which is drained back into a lower pool surrounding the standpipes 14 and maintained at a constant level by means of a liquid level regulating device 18. As described, this condensate is withdrawn and passed through the cooler 21 to be returned to the evaporating stage, or is recycled through the line 29 to the heating coil or removed from the system through the line 33. The vapors still uncondensed, which arrive at the top of the tower, are subjected to additional reflux condensation due to their being brought into contact with the preheating coil 34 through which is circulated the cool charging stock. Vapors remaining uncondensed in the tower pass off through the line 35 and are subjected to final condensation in the cooling coil 36 after which the liquid distillate is discharged into the gas separator where the incondensible gases are removed from the liquid distillate.

As described, the cracking portion of the system is maintained under relatively high pressure, while the evaporating and fractionating equipment are maintained under substantially atmospheric pressure. The utilization of a single tower to take the place of a double tower construction, i. e., a separate evaporating and fractionating tower connected by numerous lines and valves, supplies not only a compact, efficient arrangement, but eliminates considerable expense in the necessary pipes and fittings which must be used in connecting up a system having a double tower arrangement. Furthermore, better heat economy can be practiced in a system of this type.

I claim as my invention:

1. An apparatus for conversion of hydrocarbon oils comprising in combination a cracking coil, a reaction chamber, and a tower having an evaporating zone in the lower portion thereof and a fractionating zone in the upper portion thereof, means for passing the oil under superatmospheric pressure through said cracking coil into said reaction chamber, means including a pressure reducing valve for passing oil from said reaction chamber into the evaporating zone of said tower, means for maintaining the level of liquid in said evaporating zone below the point of entrance of cracked products into said zone, a packing for said evaporating zone located above the point of introduction of said products, a partition across said tower forming a vapor space above said packing, a plurality of stand pipes piercing said partition and projecting above the level thereof, bubble trays above the upper end of said stand pipes for fractionating vapors rising

through said stand pipes to form a desired distillate and a reflux condensate, means for maintaining a pool of reflux condensate below the level of the top of said stand pipes, means for withdrawing condensate from said pool, cooling it and spraying it into said vapor space, and means for varying the amount of condensate so sprayed into said vapor space.

2. An apparatus in accordance with claim 1 wherein means is provided for returning to said cracking coil condensate withdrawn from said pool.

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