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APPARATUS FOR CRACKING PETROLEUM HYDROCARBONS.

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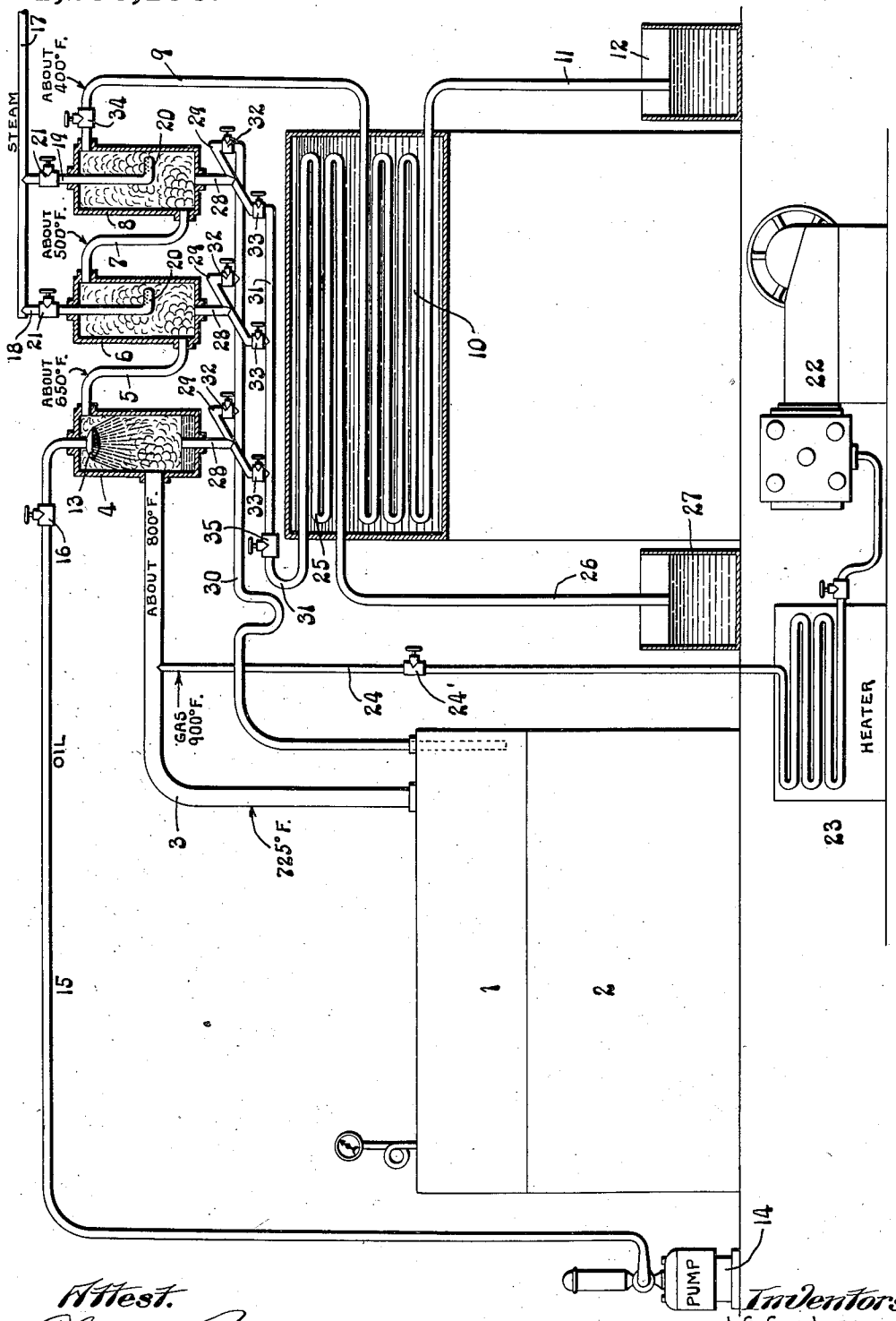

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CRACKING PETROLEUM HYDROCARBONS.

1,258,196. Specification of Letters Patent. Patented Mar. 5, 1918.

Application filed December 26, 1916. Serial No. 138,997.

To all whom it may concern:

Be it known that we, JOSHUA S. COSDEN and JOHN W. COAST, Jr., citizens of the United States of America, residents of Tulsa, in the county of Tulsa, State of Oklahoma, have invented certain new and useful Improvements in Apparatus for Cracking Petroleum Hydrocarbons, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

Our invention relates to an apparatus for cracking high boiling petroleum hydrocarbons to obtain a cracked product adapted for use as a motor spirit. The product eventually obtained is known as cracked gasolene, or a substitute for gasolene. One of the objects of the invention is to provide an economical apparatus for producing a highly desirable low boiling product of this kind.

More specifically stated, an object of the invention is to utilize the hot vapors resulting from one cracking operation to heat and crack another hydrocarbon fluid. To accomplish this, the vapors flowing from a primary cracking chamber are preferably superheated and introduced into a supplemental cracking chamber, and a finely divided hydrocarbon fluid is then forced into the superheated vapors. As a consequence, the finely divided hydrocarbon fluid is cracked and, being relatively cool, it also serves as a primary condenser for the previously vaporized high boiling hydrocarbons. The high boiling condensate resulting from this operation is preferably conducted back to the primary cracking chamber.

Another object is to increase the yield and improve the product by introducing natural gas into the hot vapors passing from the primary cracking chamber, and with this object in view, we preferably use the natural gas in superheating the vapors flowing from the primary cracking chamber. The natural gas may be heated to a very high temperature, for example 900° F., and then forced into the hot vapors, thereby superheating the vapors to such a degree that the hot fluid may be used as the heating medium for the second cracking operation.

The natural gas is forced into the hot vapors at a point where the vapors are confined under a high pressure, preferably greater than 50 pounds per square inch, and it is evident that the hot gas unites with, or is absorbed by the hot petroleum hydrocarbon vapors in such a manner as to materially increase the yield, at the same time beneficially altering the properties of the hydrocarbon fluid. Before reaching the main condenser, the hot mixture is preferably conducted, under pressure, through a steam chamber where it commingles with a spray of relatively cool steam. This causes some of the high boiling hydrocarbons to condense, and the properties of the product are further improved by the action of the steam. We are unable at this time to accurately explain the precise action which takes place when the steam is introduced into the compressed hydrocarbon mixture, but it appears that some of the constituents of the steam unite with the hydrocarbons so as to form part of the low boiling product. The steam also eliminates a large percentage of the carbon and other objectionable elements that are usually removed by treating the product with sulfuric acid.

The ordinary well known method of cracking petroleum hydrocarbons consists in subjecting the hydrocarbons, while under pressure, to a high degree of heat, thereafter conducting the vapors to a primary reflux condenser where the relatively heavy hydrocarbons are condensed and prevented from passing to the main condenser. The ordinary primary condenser also has the important function of lowering the temperature of the light hydrocarbon vapors before they reach the main condenser. All of these functions are performed by the supplemental cracking chamber and steam chambers to which we have previously referred, the elements associated with these chambers serving to economize in the use of fuel, to very materially improve the product, to increase the yield, and also to condense the high boiling hydrocarbons.

To set forth a preferred form of the invention, we have herein described a specific combination of elements arranged in a particular sequence, but it is to be understood that the invention comprehends modifications and variations within the scope of the claims hereunto appended.

The drawing is a diagrammatical view of an apparatus embodying the features of our invention.

To illustrate the invention we have shown a retort or primary cracking chamber 1 arranged over a heating chamber 2, a vapor pipe 3 leading from the primary cracking chamber 1 to a supplemental cracking chamber 4, a vapor pipe 5 connecting the upper portion of said supplemental cracking chamber to a steam chamber 6, a vapor pipe 7 connecting the upper portion of steam chamber 6 to the lower portion of a steam chamber 8, a vapor pipe 9 leading from the upper portion of steam chamber 8 to a main condenser 10, and a pipe 11 for conducting the low boiling condensate from condenser 10 to a tank 12.

A discharge member 13, arranged in the upper portion of the supplemental cracking chamber 4, is adapted to discharge a finely divided liquid hydrocarbon into the hot vapors. A pump 14 may be operated to force a high boiling hydrocarbon liquid, through a conductor 15, to the discharge member 13. 16 designates a regulating valve in the conductor 15.

A main steam pipe 17 is provided with branches 18 and 19 for conducting steam into the steam chambers 6 and 8 respectively. Each of the branch pipes 18 and 19 has a discharge member 20 at its lower end, adapted to discharge a spray of steam into the vapors. Regulating valves 21 may be adjusted to regulate the flow of steam to the steam chambers.

Natural gas passing from a gas compressor 22, is preferably forced through a superheater 23 and thence into a pipe 24 leading to the insulated vapor pipe 3. 24' designates a regulating valve in the gas pipe 24.

The condensate forming in the chambers 4, 6 and 8 may be returned to the main cracking chamber 1, or it may be conducted to a cooling coil 25 having a discharge pipe 26 for conducting the liquid to a tank 27. Discharge pipes 28 extending downwardly from the bottoms of the chambers 4, 6 and 8 are connected to branch pipes 29 adapted to communicate with a return pipe 30 which leads to the main cracking chamber 1. These branch pipes 29 are also adapted to communicate with a pipe 31 connected to the cooling coil 25. Valves 32 may be opened to place the branch pipes in communication with the return pipe 30, or if desired the valves 32 may be closed and the valves 33 opened to allow the condensate to flow to the cooling coil 25.

A pressure regulating valve 34 in the vapor pipe 9 may be adjusted to maintain any desired pressure in the steam chambers 8 and 6, supplemental cracking chamber 4 and main cracking chamber 1. A regulating valve 35, in the pipe 31, is also adjusted to maintain the desired pressure when the condensate is permitted to flow to the coil 25.

The new apparatus may be used in cracking various high boiling hydrocarbon products resulting from the distillation of crude petroleum, and is particularly adapted for use in cracking inexpensive heavy hydrocarbons having a boiling point of about 450° F. to 700° F. The substances to be treated may be introduced into the main cracking chamber 1 in any suitable manner, and the valve 34 located beyond the steam chamber 8 may be adjusted to maintain the desired high pressure in the steam chambers and cracking chambers. This pressure is greater than 50 pounds per square inch, preferably about 75 to 80 pounds per square inch.

To more clearly explain the invention, the approximate temperatures at various parts of the apparatus have been marked on the drawings, but it is to be clearly understood that these figures are not essentially accurate, the main object being to show that the temperature of the vapors is increased and decreased at different points in the apparatus.

The vapors flowing in the vapor pipe are superheated by the natural gas flowing from the heater 23 to said vapor pipe, and the hot mixture is then conducted into the supplemental cracking chamber 4. The natural gas under pressure and at a high temperature, for example, 900° F., commingles with the confined vapors, so as to increase the yield, at the same time increasing the temperature of the vapors to such a degree (for example 800° F.) that the mixture serves as a heating medium for cracking the high boiling hydrocarbon fluid passing from the discharge member 13 in the supplemental cracking chamber. The finely divided fluid discharged into this chamber is preferably a high boiling product resulting from the distillation of crude petroleum. If desired, it may be preheated, but it is preferably in a liquid state and at about the temperature of the atmosphere. This high boiling fluid is vaporized and cracked while confined under pressure in the supplemental cracking chamber, and being relatively cool, it serves as means for condensing previously vaporized high boiling fractions.

Another advantage is the elimination of coke or carbon by the action of the relatively cool liquid in the supplemental cracking chamber. A large percentage of the carbon or coke carried by the vapors, drops into a trap formed at the bottom of the supplemental cracking chamber, and the high boiling condensate overflowing into the discharge pipe 28 is preferably conducted back to the primary cracking chamber.

The hot fluid passing from the upper portion of the supplemental cracking chamber

is conducted into the steam chamber 6 where it is acted upon by a spray of relatively cool steam which commingles with the mixture of natural gas and hydrocarbon vapors. The saturated steam is superheated by the hot fluid in the steam chamber 6 and the new mixture passes out through the vapor pipe 7 and into the steam chamber 8 where it is subjected to a second treatment by a spray of relatively cool steam. To obtain the most desirable results, we preferably use two or more steam chambers, and it will be observed that such chambers serve as condensers for "knocking back" the high boiling hydrocarbons. Since the supplemental cracking chamber and steam chambers constitute a series of reflux condensers, the high boiling liquid may be vaporized very rapidly in the main cracking chamber 1. The heavy hydrocarbons carried from the main cracking chamber will be condensed in the reflux condensers, and the desired low boiling hydrocarbons will pass through the pressure regulating valve 34 to the main condenser 10. The contents of this condenser are preferably maintained under a pressure of about one atmosphere.

The method or process herein disclosed is claimed in an application for patent filed by us Dec. 26, 1916, Serial Number 138,996.

We claim:—

1. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a primary cracking chamber, a supplemental cracking chamber arranged to receive hydrocarbon vapors passing from said primary cracking chamber, means for forcing gas into the hydrocarbon vapors before they reach said supplemental cracking chamber, means for forcing a relatively cool hydrocarbon fluid into the mixture of gas and hot hydrocarbon vapors in said supplemental cracking chamber, thereby cracking said hydrocarbon fluid, and means for conducting the mixture of gas and hydrocarbon vapors from said supplemental cracking chamber.

2. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a primary cracking chamber, a condenser, a vapor conductor leading from said primary cracking chamber to said condenser, said vapor conductor including a supplemental cracking chamber, a pressure regulating device arranged to maintain a pressure greater than 50 pounds per square inch in both of said cracking chambers, a pumping apparatus arranged to force natural gas into said vapor conductor, and a pumping apparatus arranged to force a relatively cool high boiling hydrocarbon fluid into the mixture of natural gas and hot vapors in said supplemental cracking chamber, thereby cracking said hydrocarbon fluid and at the same time condensing the previously vaporized fractions having relatively high boiling points.

3. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a cracking chamber, a condenser, means for conducting vapors from said cracking chamber to said condenser, said means including a supplemental cracking chamber, a pressure regulating device arranged to maintain the contents of said cracking chambers under a pressure greater than 50 pounds per square inch, a heating device arranged to superheat said vapors, said heating device including a pump, a gas conductor for conducting gas from said pump to the vapor conductor and means for heating said gas conductor; and a pumping device arranged to force a relatively cool high boiling hydrocarbon fluid into the superheated vapors in said supplemental cracking chamber, thereby cracking said hydrocarbon fluid.

4. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a primary cracking chamber, a condenser, means for conducting vapors from said primary cracking chamber to said condenser, said means including a supplemental cracking chamber and a steam chamber adapted to receive vapors passing from said supplemental cracking chamber, means for discharging steam into the vapors in said steam chamber, and means for discharging a relatively cool hydrocarbon fluid into the vapors in said supplemental cracking chamber, thereby cracking said hydrocarbon fluid.

5. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a cracking chamber, a series of reflux condensers arranged to receive vapors passing from said cracking chamber, one of said reflux condensers being a supplemental cracking chamber provided with means for discharging a relatively cool hydrocarbon fluid into the vapors, another of said reflux condensers being a steam chamber provided with means for discharging steam into the vapors which pass from said supplemental cracking chamber to said steam chamber, a pressure regulating device arranged to maintain the contents of all of said chambers under a pressure greater than about three atmospheres, and a main condenser arranged to receive vapors passing from said steam chamber.

6. In an apparatus for cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, a cracking chamber, a series of reflux condensers arranged to receive vapors passing from said cracking chamber, one of said reflux condensers being a supplemental cracking chamber provided with means for discharging a relatively cool hydrocarbon fluid in the vapors,

another of said reflux condensers being a steam chamber provided with means for discharging steam into the vapors which pass from said supplemental cracking chamber to said steam chamber, means for superheating the vapors before they reach said supplemental cracking chamber, a pressure regulating device arranged to maintain the contents of all of said chambers under a pressure greater than about three atmospheres, and a main condenser arranged to receive vapors passing from said steam chamber.

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