

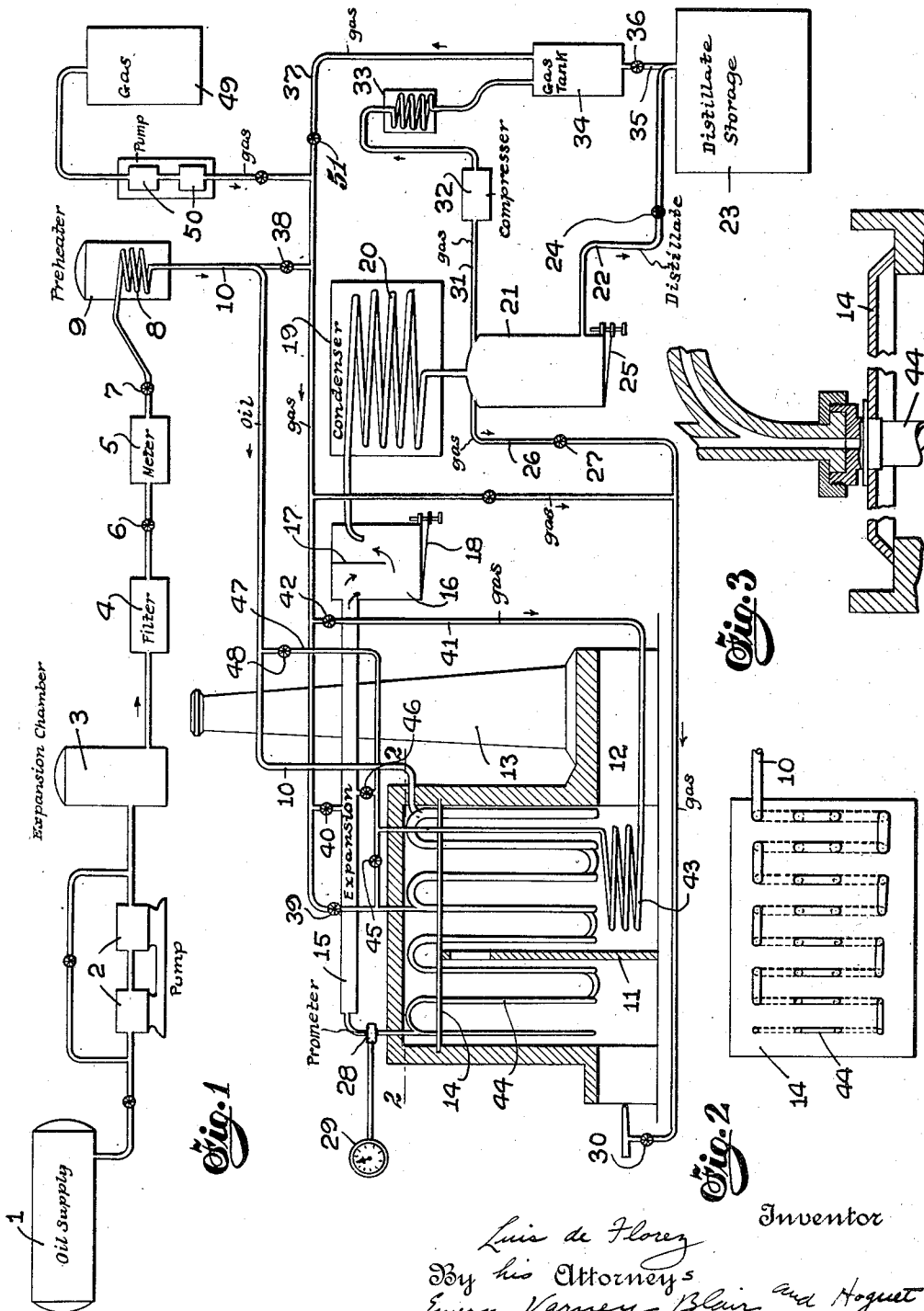
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APPARATUS FOR TREATING HYDROCARBONS

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APPARATUS FOR TREATING HYDROCARBONS.

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The present invention relates to improvements in apparatus for cracking oils to produce low boiling hydrocarbons from similar material having relatively high boiling points. One object of the present invention is to produce, in commercial quantities, a distillate of suitable characteristics to be used as fuel in internal combustion engines, in such a manner as to reduce the loss of valuable products commonly resulting in so-called cracking operations as heretofore practiced.

Various methods of cracking or decomposing hydrocarbons by subjecting them to relatively high pressures and temperature, as heretofore generally practiced, have frequently involved material losses in the form of undesirable products produced in too great proportion during the recovery of valuable products. These undesirable products include gas, residue, or heavy boiling material and coke. It is known in connection with so-called cracking operations, that a certain proportion of material will go to form a gaseous product which retains its identity as a gas at normal temperature and pressure, while the balance will produce liquid products of low boiling and high boiling properties. The proportion in which these products are formed is a relatively constant one, that is to say, with a given method of treatment of a given raw material and assuming no defects in the apparatus, gas and liquid products will be formed in virtually uniform proportion. It has been observed that, if during the operation of the cracking process, a portion of the gas resulting from the cracking of a given amount of raw material be withdrawn from the system, a new formation or readjustment of the relative amounts of gas and liquids will take place and it will be found that an additional amount of gaseous products will be formed, thus increasing the gaseous product at the expense of the liquid product. To avoid this loss of liquid product where it is desired to withdraw gas for certain useful purposes, I propose to inject a portion of the gas normally formed by operation of the process, or otherwise provided, into the system along with the oil which is under treatment, so that a balance between the gaseous compounds and other products will be established to such an extent as to minimize the formation of new gas. It

is contemplated that the formation of less gas from each increment of material treated will tend to increase the proportion of desired liquid products.

One of the chief practical difficulties in cracking oils results from the fact that the oil will deposit a certain amount of carbon during the process. In certain types of apparatus, the carbon deposit materially interferes with the proper functioning of the apparatus. When cracking in a still or large container, the deposition of carbon is commonly allowed to take place on the sides and may conveniently be removed by hand at suitable intervals. However, it will be evident that when the oil cracking process takes place in tubes, the deposition of carbon is a more serious matter and unless controlled effectively, it prevents the uniform flow of oil through the apparatus, thus making it necessary to cease operations and to clean the tubes. This procedure obviously interferes with economical and effective operation of the plant and no tubular apparatus is really a commercial success unless suitable means are provided for readily removing the carbon in operation, or for positively preventing its deposition at critical points. Mechanical means commonly used for removing carbon deposits have not been found practicable since the working parts necessarily operate under unfavorable conditions of temperature. I propose to improve tubular processes in part by preventing deposition of carbon in the tubes in any practical manner such as by increasing the velocity of the fluid in the tubes, said velocity being controlled by suitable means, as by temperature and variation in the cross sectional area of tube opening, or by either one independently of the other. In practice, satisfactory variation in tube section may be accomplished by the use of pipes of varying standard sizes. In addition to this particular means of increasing the speed of velocity of the liquid in the tubes, further increase may be effected by increasing the volume of the fluid by raising its temperature. The effect of carrying the fluid through the pipes at high velocity is twofold. First, it causes a turbulent flow which insures good heat transfer due to extensive contact of the fluid with the sides of the pipe and therefore uniform heating of the material passing through. Secondly, high speed of

flow entrains carbon about to be deposited along with the fluid in vapor form to a point where it may be desirable to drop the carbon by any suitable expedient such as a change in direction of flow or a partial cooling of the fluid, or expansion.

One embodiment of my invention is illustrated in part diagrammatically in the drawings accompanying the present specification, and in which

Figure 1 is a schematic view, generally in elevation but with portions broken away and portions in vertical section,

Figure 2, a horizontal section on the line 2-2 of Figure 1,

Figure 3, a detail view partly in vertical section showing connection between the oil vapor conduit and the gas conduit.

Referring to said drawings, the liquid hydrocarbon to be treated may be drawn from a suitable container, such as a running tank 1, by means of a pump 2 arranged to force the oil into an expansion chamber or riser 3. The expansion chamber acts as a cushion to overcome the effect of pulsations of the charging pump 2 and to insure the uniform delivery of oil to the converter. From this expansion chamber, and by reason of the pump pressure, the hydrocarbon passes through a filter 4 constructed in such a manner as to remove from said hydrocarbon all sediment and solid materials. The hydrocarbon thus purified flows through a meter 5 either at the pressure substantially as produced by pump 2, or at a reduced pressure effected by means of a regulating valve 6 interposed between said meter and the filter 4. In case it is desired to reduce the pressure after passage of the hydrocarbon through the meter, a regulating valve 7 may be provided. After passing through the meter, the hydrocarbon may be heated to a predetermined temperature by any suitable means, here shown as a coil 8 enclosed in a steam chest 9.

The apparatus may also include a suitable furnace for heating the hydrocarbon from atmospheric temperature to a suitable oil cracking temperature, such as approximately 610° centigrade, a preferred form of said furnace being indicated diagrammatically in the drawings and comprising substantially a combustion chamber and a heating chamber communicating therewith and having a baffle 11 interposed in the path of the products of combustion which may be permitted to escape through a flue 12 and thence to the atmosphere through a chimney 13, if desired. The hydrocarbon coming from the steam heated coil 8 through a feed pipe 10 is carried through the heating chamber of the furnace through a suitable conduit 44 comprising a series of bends of pipe depending into the heating chamber from a suitable supporting element or top plate 14. The bends of pipe comprising the conduit supported by the top plate 14, are

connected in series and are of such dimensions that the hydrocarbon flows successively from pipes of relatively large diameter to pipes of relatively small diameter. As shown in Figure 1, the hydrocarbon carrying feed pipe 10 discharges the hydrocarbon into conduit 44 at a relatively cool portion of the heating chamber and the temperature of the hydrocarbon is gradually raised as it passes through convolutions of the conduit depending in increasingly hotter portions of the heating chamber. A suitable arrangement of pipes constituting the conduit for conveying the hydrocarbon through the heating chamber may include a plurality of two inch pipes receiving hydrocarbon directly from the feed pipe 10. From the two inch pipes, the hydrocarbon may be led through a plurality of one and one-half inch pipes and thence into a plurality of one inch pipes, said one inch pipes being arranged in that portion of the heating chamber in which the maximum or predetermined cracking temperature is available.

It is contemplated that the hydrocarbon will be entirely vaporized, under normal conditions of operation, in a portion of the conduit located in a cooler portion of the heating chamber than that in which the cracking takes place. The vapor thus formed will then pass into pipes located in a relatively hotter portion of the chamber where cracking will be effected, the resulting product being then carried to an expansion chamber 15 in which it is intended that the deposition of carbon and other residual products shall take place, such as materials having boiling points ranging from 300° centigrade and upwards, if desired. The expansion chamber 15 may include a receptacle 16 having a baffle 17 arranged opposite the opening of expansion chamber 15, said receptacle and baffle being adapted to effect a further deposition of carbon which may be readily removed from said receptacle through a door 18 hinged to the bottom of said receptacle. A condensing chamber 19 encloses a condensing coil 20 carrying the vaporized and cracked hydrocarbon, said coil being arranged to discharge the products of condensation into a receptacle or tank 21 from which the liquid deposit may be withdrawn through a suitable pipe 22 to a storage tank 23, said pipe 22 being provided with a valve 24. A door 25 may be secured to the bottom of tank 21 for the purpose of removing sedimentary deposits too heavy to flow through the pipe 22. The product thus normally drawn off through the pipe 22 will include the distillates which it is the object of the above described method and operation of the apparatus to produce.

Under normal conditions of operation, the tank 21 will also contain a hydrocarbon gas resulting from the condensation of the vaporized and cracked hydrocarbon. A portion of this gas may be withdrawn from tank 21 by means of a conduit 26 controlled by a valve 27

and conducted through said conduit to the combustion chamber of the heating unit where the gas may be utilized to produce the heat required in the operation of vaporization and cracking the hydrocarbon in conduit 44.

In order to maintain a predetermined cracking temperature in said conduit and in the heating chamber of the heating unit, suitable temperature controlling means may be provided including a pyrometer 28 of any suitable construction preferably arranged in a portion of the conduit which carries the cracked hydrocarbon. This pyrometer may be operatively connected with an indicator dial 29 arranged in such position that the operator may readily perceive any deviation from the predetermined temperature and control said temperature by increasing or diminishing the supply of fuel in the combustion chamber. For this purpose a hand operated valve 30 may be provided. Obviously, the adjustment of fuel supply may be made automatic by suitable controlling mechanism interposed between a fuel supply controlling valve and the pyrometer 28.

Another portion of the gas formed in tank 21 may be drawn therefrom through a pipe 31 and into a compressor 32 from which it is forced through a condenser 33 and into a reservoir 34. Any liquid or distillate deposited in this reservoir by reason of the further cooling of the gas may be withdrawn therefrom through a pipe 35 controlled by a valve 36 into the storage tank 23.

Where it is desired to utilize the gas pumped into tank 34 as described by introducing it into the hydrocarbon at any desired point in the cracking operation, a feed line 37 may be arranged to connect said tank with the liquid hydrocarbon feed pipe 10, or with the conduit 44, or with the expansion chamber 15, valves 38, 39 and 40 being provided to control the flow of gas into the feed pipe 10, the conduit 44, and the expansion chamber 15, respectively, it being contemplated that the pressure at which the gas is admitted to these various parts may be in part controlled through manipulation of said valves.

Where it is desired to heat the gas drawn from tank 34, before introducing it into the portions hereinabove referred to, the gas may be deflected into a pipe 41 through a valve 42, under which conditions the valves 38, 39 and 40 may be either partially or entirely closed, as circumstances require. When valve 42 is open, gas may be fed through pipe 41 into a coil 43 located in the heating chamber of the heating unit and may be admitted into the conduit 44 through a valve 45, or into the expansion chamber 15 through a valve 46. If it is desired to introduce the heated gas into the relatively cool liquid hydrocarbon in the feed pipe 10, a pipe line 47 may be ar-

ranged to connect with said feed pipe 10, said line 47 being conveniently controlled by a valve 48.

Under some conditions of use, it is contemplated that a supply of any suitable inactive gas may be maintained in a conveniently arranged receptacle 49 from which it may be pumped into the pipe line 37 by means of a pump 50. A valve 51 interposed in said pipe 37 may be utilized to prevent the forcing of gas from the tank 49 into tank 34.

In operation, it has been found that a suitable primary operating pressure on the liquid hydrocarbon is approximately 250 pounds, said pressure being developed in pump 2. This primary pressure may be stepped down to provide a suitable feed pressure either by means of the regulating valve 6 or the regulating valve 7 arranged respectively at either side of the meter 5, it being desirable to regulate the flow of hydrocarbon so that it may be constant. The initial feed pressure of 125 pounds is substantially maintained throughout the system until the hydrocarbon is vaporized after which the pressure will be reduced until the hydrocarbon reaches the distillate receiving tank 21 in which a pressure of approximately 15 pounds may be maintained. To force the gas from tank 34, or from tank 49, into the circulating system at the points hereinabove mentioned, or others, it will be found that a pressure approximately equal to or slightly greater than that existing at the particular point of entry may be used.

In practicing the method hereinabove outlined in connection with the apparatus described, it will be understood that one of the objects of my invention is accomplished by introducing into the hydrocarbon a suitable inactive gas, preferably one which when mixed with the hydrocarbon will not promote combustion, such as a hydrocarbon gas which will combine with the oil under treatment, thus providing such an excess of gas in the cracked and vaporized hydrocarbon that a relatively smaller proportion of gas formation will be found to have taken place under condensation of said vaporized and cracked hydrocarbon than is ordinarily found where the excess of gas is not so introduced. Thus, by restricting the amount of gas product, I proportionately increase the amount of the desired liquid product thereby effecting a material economy in the operation of a plant of the character described.

A further object of my invention is attained in the increasing of the velocity of the hydrocarbon passing through conduit 44 in the heating chamber of the heating unit. By gradually reducing the cross sectional area of the opening of the conduit, I effect a corresponding increase in the speed of the hydrocarbon vapor as it passes through said conduit, said speed being so great that the

tendency of particles of carbon to deposit is overcome and the carbon is carried along into the expansion chamber 15 and the expansion receptacle 16 where it may be deposited without interfering with the continuous operation of the plant. The speed of the vaporized hydrocarbon is further increased in the relatively constricted portions of the conduit by the increased temperature maintained in that portion of the heating chamber in which the more constricted portions of the conduit 44 are arranged, the combination of additional heat and constricted opening operating to produce such a speed that carbon will not be deposited in the conduit.

I claim as my invention:

1. Vaporizing apparatus for hydrocarbons comprising a source of heat, a heating chamber having vaporizing members depending therein, said members in the hotter zone of the heating chamber having a reduced cross sectional area as compared with

the cross sectional area of the depending members in the cooler zone of the heating chamber, and means for introducing the hydrocarbons to the vaporizing members of larger area for passage thence to the vaporizing members of reduced area.

2. Vaporizing apparatus for hydrocarbons comprising a source of heat, a heating chamber, a vaporizing coil depending into said chamber and having a reduced portion to increase the rate of flow of the hydrocarbons, means for introducing the hydrocarbons under pressure into the larger portion of the coil and forcing the hydrocarbons thence to the reduced portion and means for introducing gas into said coil to lower the density of the hydrocarbons.

In testimony whereof, I have signed my name to this specification this 20th day of June, 1919.

LUIS DE FLOREZ.