

July 11, 1939.

P. J. SWEENY

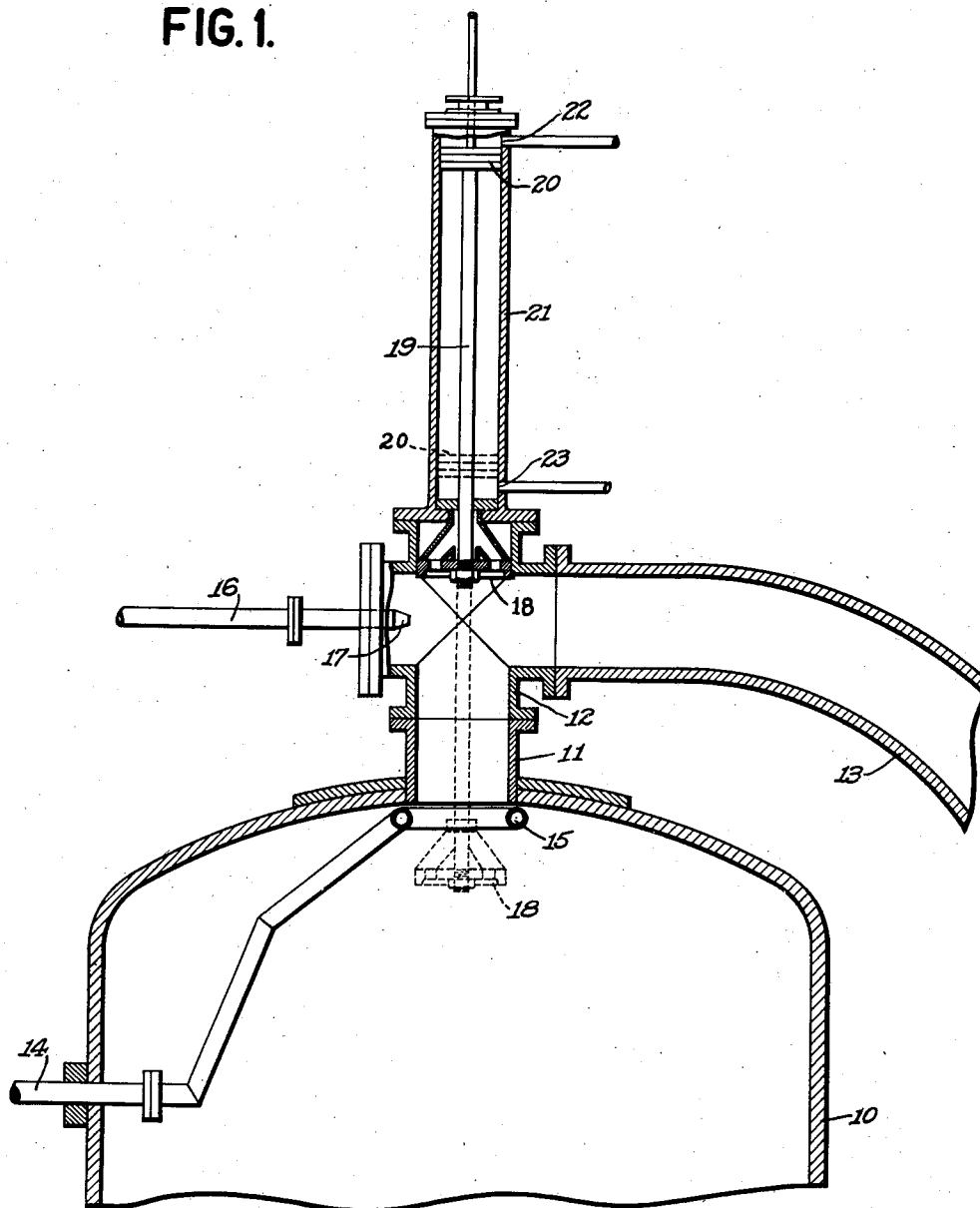
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CRACKING HYDROCARBON OILS

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FIG. 1.



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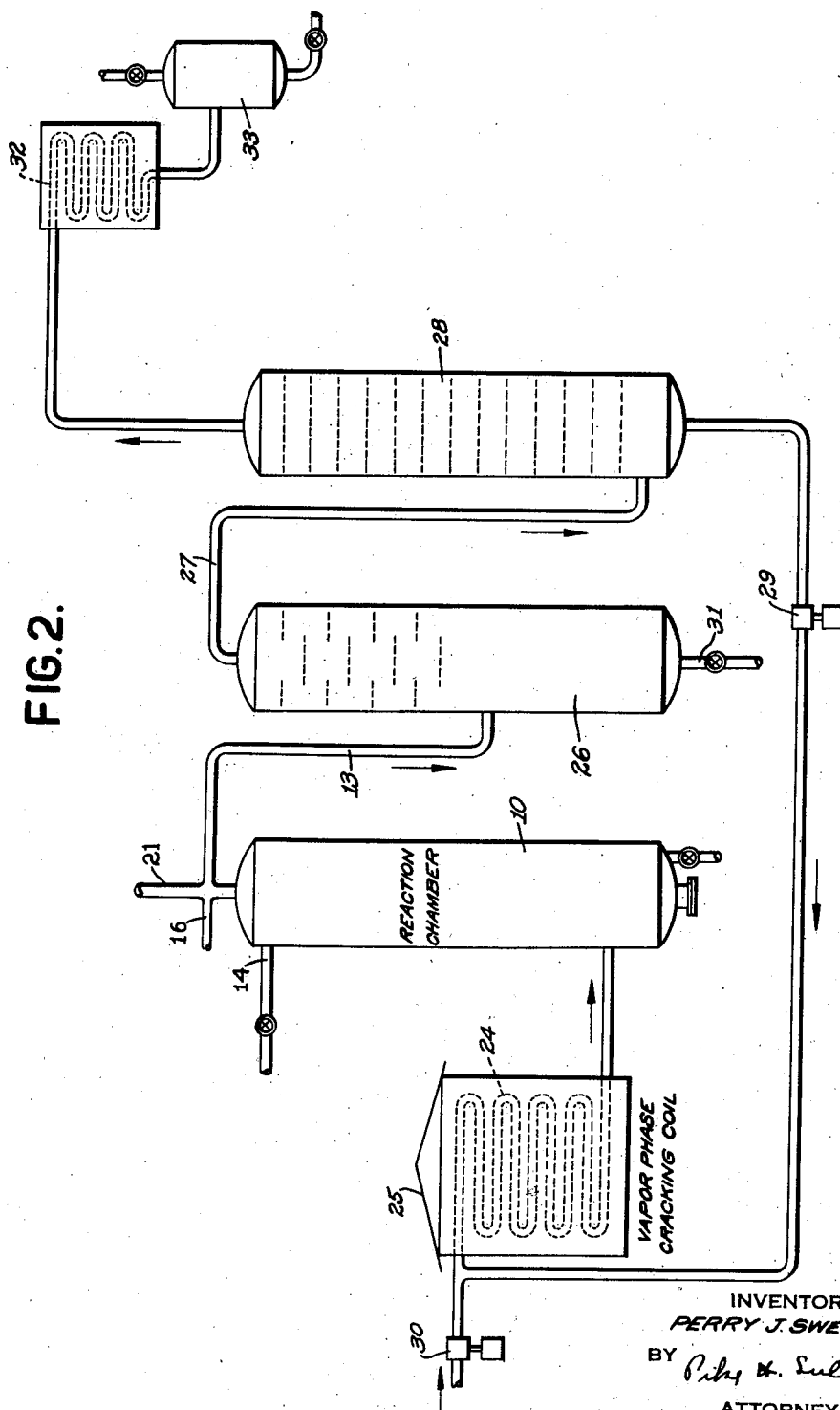
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FIG. 2.



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CRACKING HYDROCARBON OILS

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3 Claims. (Cl. 196—58)

This invention relates to the cracking of hydrocarbon oils and pertains more particularly to a method of inhibiting coke deposition in vapor lines employed for transferring hot cracked vapor products from a vapor phase reaction chamber to other parts of the cracking equipment wherein the cracked products are separated into the desired components.

It is desirable to maintain vapor phase cracking chambers at temperatures upwards of 850° F. in order to maintain a sufficiently high rate of cracking as to sustain reactions conducive to the formation of gasoline constituents of high anti-knock quality. A difficulty is presented in such an operation in the removal of the vapors from the reaction chamber through the usual vapor line due to the fact that there is a pronounced tendency for carbon deposition immediately adjacent the entrance to the vapor line as well as in the subsequent portions of the vapor line. The tendency toward carbon deposition is especially pronounced in systems in which the vapors leave the reaction chamber after very extensive cracking with high rates of cracking per pass. The problem of cooling the exit vapors is complicated by the fact that it is desirable to deliver the products from the reaction chamber to the subsequent fractionating equipment at high temperatures which may in fact be within the cracking range. Furthermore, it is necessary that the cooling applied be of a highly localized nature in order to avoid cooling the mass of vapors in the reaction chamber. The vagaries of carbon formation and deposit are frequently difficult to understand. Thus in the vapor phase cracking of certain stocks, it has been sought to introduce a distillate or vaporizable stock adjacent the entrance to the vapor line, but the use of the distillate stock has, in these cases, proved ineffectual in keeping the vapor line and especially the entrance to the vapor line, free from serious coke deposition.

In accordance with my invention a heavy residual stock of the nature of reduced crude petroleum is introduced in limited quantities into the outgoing vapors at a point immediately adjacent the entrance to the vapor line. The amount of heavy stock thus introduced is of a critical character since sufficient stock must be introduced to effectually inhibit coke deposition without unduly cooling the vapors. Furthermore, the quantity introduced must be limited to an amount which can be carried out by the outflowing vapors so that no material quantity of the heavy stock will drop down into the mass of vapors in

the reaction chamber which would result not only in cooling the vapors undergoing reaction in the reaction chamber, but would also cause coking in the reaction chamber. By introducing the heavy stock in quantities approximating 5% to 7% of the charge into the reaction chamber coke deposition at the entrance to the vapor line may be inhibited without unduly cooling the vapors and without dissipating the heavy stock into the reaction chamber. A crude oil residuum contains, and in fact may consist largely of constituents that are not vaporizable, without decomposition, except under a vacuum. When the heavy stock containing unvaporizable constituents is introduced in proper quantities into the outflowing vapors it appears to operate as a fluxing or coke inhibiting agent in spite of the high temperature of the operation.

In accordance with the invention the introduction of the heavy stock at a point adjacent the entrance to the vapor line may be followed with the introduction of an additional cooling agent to further reduce the temperature of the cooled products and thus effectually maintain the vapor line free from obstructing deposits of carbon. In a preferred embodiment of the invention the secondary cooling stock is a condensate oil. The secondary cooling agent may be introduced in quantities in excess of the quantity of heavy stock or primary cooling agent introduced.

The invention may be more completely described by reference to the accompanying drawings wherein:

Fig. 1 is a partial sectional elevation of a reaction chamber arranged for the practice of the invention.

Fig. 2 is a flow diagram illustrating a particular embodiment of the invention.

Referring to Fig. 1 a reaction chamber 10 is provided with a vapor line in the form of a riser 11, a cross fitting 12 and a line 13, constituting a passageway of restricted cross-sectional area for conducting the vapors to subsequent fractionating equipment.

A line 14 terminates in a spray ring 15 which is disposed concentric with the vapor outlet or riser 11 and is adapted to discharge a cooling stream directly into the path of vapors flowing into the vapor outlet. The heavy stock or reduced crude is sprayed by means of the ring 15 into the stream of vapors entering the riser 11.

For introducing the secondary cooling stock a pipe 16 having a nozzle 17 is provided for projecting the cooling medium into the cross fitting 12 and into the path of vapors flowing in the

line 13. In this way the stream of hot vapors, primarily cooled by the heavy stock introduced by the spray ring 15, is immediately thereafter subjected to further cooling by the additional cooling agent introduced by the pipe 16.

For the purpose of removing any coke deposits that may form in the vapor outlet, particularly in the riser 11 or in the vertical leg of the cross fitting 12, a plunger 18 is provided. The plunger is connected by a rod 19 to a piston 20 mounted in a cylinder 21 provided with ports at 22 and 23 for a suitable actuating fluid.

It may be explained that when operating at temperatures approximating 900° F. or higher in the reaction chamber 10, it is in many cases impossible, even with the double cooling means described herein, to wholly eliminate the formation of some carbon deposition in the vapor line. Thus there is frequently some tendency toward the building up of a ring of coke at the lower end of the riser 11. But by operating in the manner described herein, in which the heavy residual stock is introduced through spray ring 15 in proper quantities and an additional cooling medium is introduced through pipe 16, it is possible to so reduce the tendency to carbon deposition that with the occasional use of the plunger 18 the passages are kept free and open for the transfer of the vapors.

In the vapor phase cracking of light gas oil stocks obtained from certain of the Gulf Coast crudes, it was found that when a distillate stock was introduced through the spray ring 15, coke deposits were formed which could not be removed by the plunger, necessitating premature shut-downs. But by practicing the invention in which reduced crude was introduced through the spray ring 15, coke deposition was eliminated to such an extent that with the occasional use of the plunger the passages were kept open for the transfer of the vapors and coking in the vapor line was entirely eliminated as a cause of shut-downs.

In Fig. 2 is shown a typical flow which may be employed in the practice of the invention. Thus a vapor phase cracking coil 24 mounted in a furnace 25 is shown discharging into the lower portion of the reaction chamber 10. The vapor line 13 is shown extending to an evaporator or separator 26 having a vapor line 27 extending to a fractionating tower 28. The charge to the vapor phase cracking coil 24 may consist of reflux condensate withdrawn from tower 28 by pump 29 as well as raw light gas oil stock, as obtained from a crude distilling unit, introduced by pump 30. A draw-off line 31 is provided for withdrawing tar from the separator 26 as to a suitable tar or residue flashing unit. The overhead vapors from the tower 28 are condensed in condenser coil 32 and the desired distillate is collected in receiver 33.

In practicing the invention in accordance with the flow diagram of Fig. 2, a light gas oil stock that is substantially completely vaporizable is introduced by the pumps 29 and 30 and raised to temperatures of about 900° F. to 1050° F. in the cracking coil 24 and the heated products discharged into the reaction chamber 10 in which a temperature of about 900° F. is maintained. The operation is carried on with a rate of cracking per pass (as measured by conversion into gasoline of 400° F. end point) of upwards 20%-25%. In a typical operation the rate of cracking per pass in the heating coil 24 may be about 14%, with about 6% in the reaction chamber 10. A

limited quantity of reduced crude is introduced through the spray ring 15 and a somewhat larger quantity of condensate stock, such as gas oil, is introduced through the line 16 to maintain the products flowing through the line 13 at about 800° F. The reaction chamber 10 is suitably maintained under superatmospheric pressures of about 200 to 400 pounds.

A typical operation in accordance with the invention was practiced in a combination unit in which a composite light gas oil consisting of virgin gas oil from the crude stripping portion of the combination unit and reflux condensate obtained in the fractionation of the vapors from the vapor phase reaction chamber was charged to the cracking coil 24 at a rate of 1580 barrels per hour. The temperature of the cracking coil outlet was 936° F.; the temperature in the vapor phase reaction zone was 894° F. under 207 pounds pressure. Reduced crude was introduced through the spray ring 15 at a rate of 90 barrels per hour, and gas oil was introduced through the line 16 at a rate of 175 barrels per hour. The temperature of the commingled products flowing through the vapor line 13 after the double cooling was 810° F. The pressure in the evaporator 26 was 205 pounds. By operating under these conditions and with the occasional use of the plunger 18, it was possible to maintain the unit on stream for an indefinite period, the coking in the vapor line being completely eliminated as a cause for a shut-down.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In the art of cracking hydrocarbon oils wherein a heated condensate stock is introduced into a reaction chamber in which a body of oil vapors is maintained at cracking temperature and from which vapors are withdrawn at a cracking temperature from the upper portion thereof through a vapor line of restricted cross sectional area, the method of inhibiting coke deposition in the vapor line which comprises introducing into the hot vapors passing from the reaction chamber at a point immediately adjacent the entrance to the vapor line a heavy oil stock of the nature of reduced crude, comprising unvaporizable constituents and approximating in quantity in a given unit of time 5% to 7% of the amount of the condensate stock introduced to the reaction chamber in the same unit of time and immediately thereafter introducing into the resultant stream of cooled products in the vapor line a vaporizable stock in quantity sufficient to further reduce the temperature of the products flowing through the vapor line but in insufficient quantity to reduce the temperature below a cracking temperature.

2. In the art of cracking hydrocarbon oils wherein a heated condensate stock is introduced into a reaction chamber in which a body of oil vapors is maintained at cracking temperature and from which vapors are withdrawn at a cracking temperature from the upper portion thereof through a vapor line of restricted cross sectional area, the method of inhibiting coke deposition in the vapor line which comprises introducing into the hot vapors passing from the reaction chamber at a point immediately adjacent the entrance to the vapor line a heavy oil stock of the nature

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of reduced crude and comprising unvaporizable constituents, approximating in quantity in a given unit of time 5% to 7% of the amount of the condensate stock introduced to the reaction chamber in the same unit of time and immediately thereafter introducing into the resultant stream of cooled products in the vapor line a materially larger quantity of cooling medium to thereby further reduce the temperature of the products flowing through the vapor line.

3. In the art of cracking hydrocarbon oils wherein a heated condensate stock is introduced into a reaction chamber in which a body of oil vapors is maintained at cracking temperature and from which vapors are withdrawn at a cracking temperature from the upper portion thereof through an upwardly rising vapor line of restricted cross sectional area and thence into a horizontally extending vapor line, the method

of inhibiting coke deposition in said vapor line which comprises introducing into the hot vapors passing from the reaction chamber at a point immediately adjacent the entrance to the upwardly rising vapor line a heavy oil stock of the nature of reduced crude, comprising unvaporizable constituents and approximating in quantity in a given unit of time 5% to 7% of the amount of the condensate stock introduced to the reaction chamber in the same unit of time and introducing into the resultant stream of cooled products flowing through the horizontally extending vapor line a materially larger quantity of cooling medium to reduce the temperature of the stream of products flowing therein but in insufficient quantity to reduce the temperature below a cracking temperature.

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