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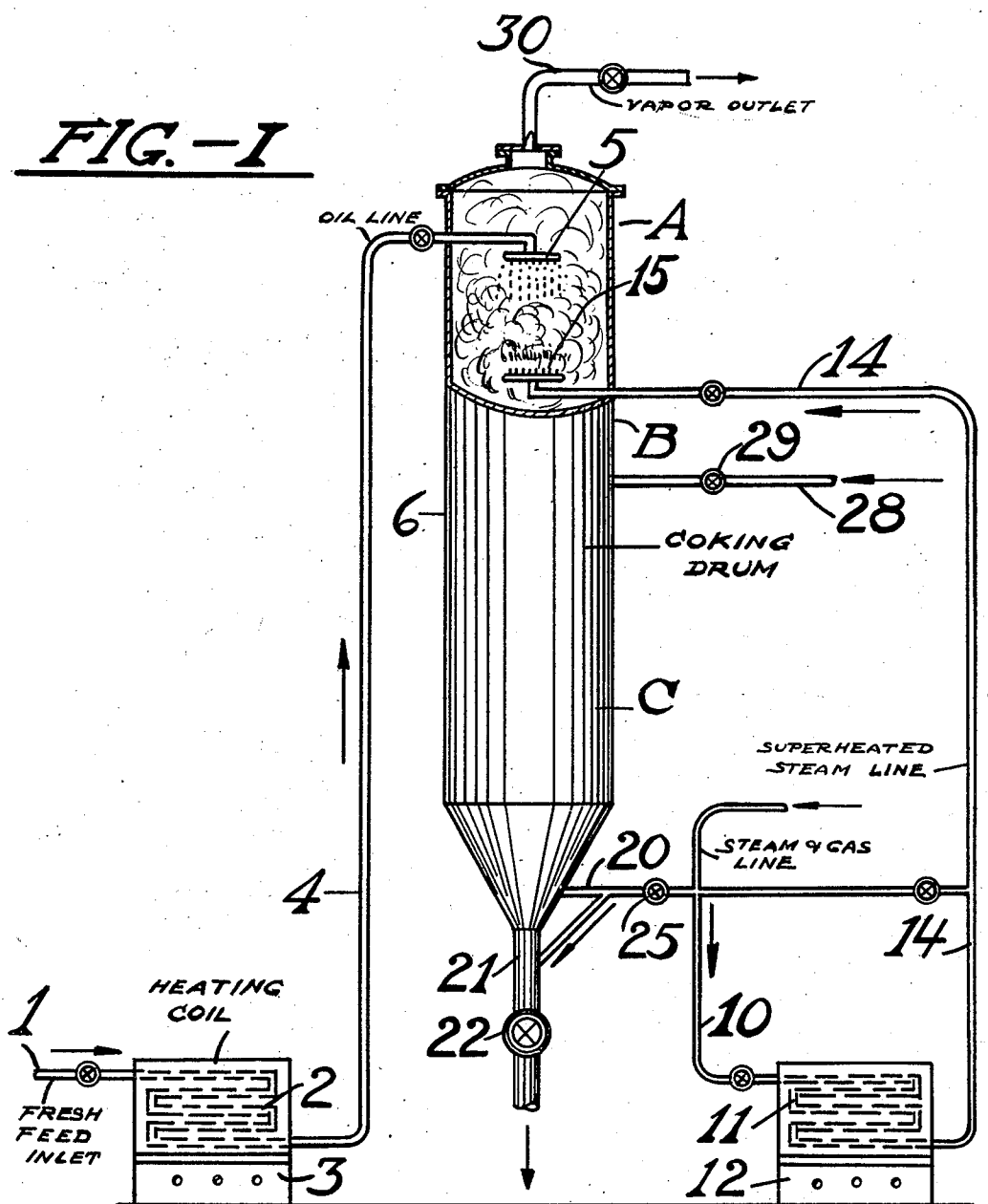
2,309,540

ART OF TREATING HYDROCARBONS

Filed Feb. 17, 1940

2 Sheets-Sheet 1

FIG. -I



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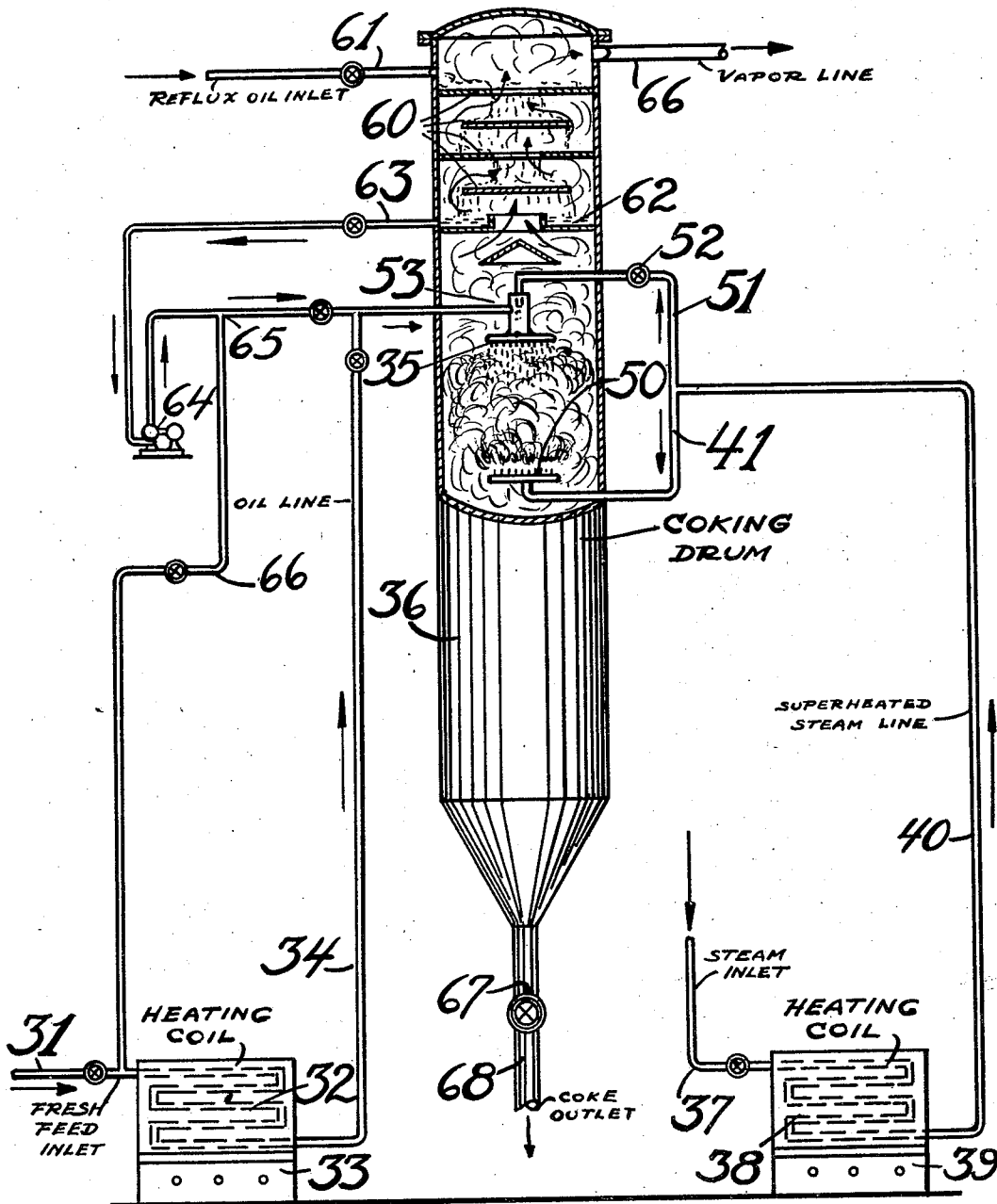


FIG.-II

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UNITED STATES PATENT OFFICE

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ART OF TREATING HYDROCARBONS

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Application February 17, 1940, Serial No. 319,396

3 Claims. (Cl. 196—63)

The present invention relates to the art of treating hydrocarbons. More particularly, the present invention relates to the continuous process of coking a relatively high boiling hydrocarbon oil to produce, among other products, an easily crushable or disintegratable coke and also a cracking stock which is suitable for use in a catalytic or thermal cracking operation.

It is a primary object of the present invention to reduce by simple and destructive distillation, a petroleum oil from any source under such conditions of feed rate of oil to a coking zone, temperature of said oil as fed to said zone, and temperature and amount of steam or other gas fed to the coking zone, as an aid in the process, to produce a frangible coke, which coke may be easily removed from the said coking zone.

It is a second object of the present invention to treat an oil having an A. P. I. gravity of say 12° to 25°, under certain conditions, hereinafter fully explained, in a coil or drum, in which treatment the vaporized hydrocarbons are removed from the coil or drum immediately following their liberation from the liquid oil.

Other and further objects will hereinafter appear from the ensuing description and claims.

We appreciate that the prior art contains numerous patents and publications relating to the process of coking reduced petroleum crudes. In so far as we are aware, however, there is no prior disclosure, nor does any prior research anticipate the real substance of our present invention, which, as stated, relates primarily to a process in which we have discovered the critical conditions or range of conditions for carrying out the process to secure the results indicated hereinbefore. One of the outstanding advantages of our process over any prior work with which we are familiar, resides in the possibility of producing a coke which is not hard and tenacious, but rather is granular and porous, and in one form of our invention sufficiently brittle so that lumps or fragments of the same may be readily crushed between one's fingers. This represents an important advance in the art because such coke will not adhere tenaciously to the inner walls of the coking drum, but rather, for the most part, will flow freely through the discharge end of said drum. Any portions of the formed coke which tend to adhere to the inner walls at the base of the drum can be easily removed from the said walls by mechanical scrapers or other suitable means. It is pointed out that an important feature of our invention resides in the continuity of the coking operation which results in a continuous discharge of coke from the drum

and thus obviates the necessity for frequent interruptions to scrape manually from the interior of the coking drum, tenaciously adherent coke.

Our invention is fully disclosed in the present specification and claims, reference being had to the accompanying drawings.

In the accompanying drawings Fig. I represents diagrammatically and in partial vertical section, one form of apparatus in which our invention may be performed and comprises essentially an elongated vertical cylinder or drum having a conical base, means for separately supplying atomized oil and steam, flue gas, etc., to said drum and means for introducing quenching steam or other gas at the other or discharge end of said zone; in Fig. II, a modification of the apparatus shown in Fig. I is illustrated, and it will be noted that in this modification means are provided for supplying stripping steam to the oil before the latter is fed to the atomizing means, all of which features and others in both modifications will more fully and at large appear from the following detailed description.

Referring in detail to Fig. I, a fresh feed comprising an East Texas reduced crude petroleum oil having an A. P. I. gravity of about 17.2° and representing an approximately 18% residue remaining after lower boiling constituents of the crude had been removed, is introduced into the system through line 1 and then passed through a heating coil 2 disposed in furnace setting 3, where the oil is heated to a temperature of about 900° F., and at this temperature it is discharged into line 4 and thence conducted to a spray nozzle 5 located as shown in the upper portion (but not at the top) of a coking drum 6 from which nozzle the oil emerges in atomized form. The oil is fed to the drum at a rate such that if it were at atmospheric temperature it would amount to about 0.5 volume of cold oil per volume of drum per hour. At the same time, steam from some source is conducted through line 10 into a coil 11 disposed in furnace 12 where the steam is superheated, withdrawn through line 14 and discharged into a spray nozzle 15 disposed within said drum in juxtaposition and spaced relation to nozzle 5. The steam moves upwardly against the downwardly moving oil droplets discharged from nozzle 5, and the steam temperature at the spray head 15 is at least as high but preferably is higher than the temperature of the oil ejected from nozzle 5. The use of steam provides means for removing vapor from the finely divided oil and simultaneously provides some of the energy (or heat) for the highly endothermic coking re-

action by raising the temperature of the oil droplets appreciably above the temperature otherwise possible inasmuch as the heavy oil such as described above is heated to high temperature with some difficulty due to the tendency of such an oil to deposit coke in a heating coil. For example, the temperature of the steam as it emerges from nozzle 15 may be 975° F. Of course, the effectiveness of the superheated steam in raising the temperature of the oil droplets depends upon the quantity of steam, relative to the quantity of oil, introduced through nozzle 15 but ordinarily its amount is in the order of 20% by weight based on the oil feed. The drum 6 may be considered, for purposes of illustration, to consist of three zones, A, B, and C, the zone A representing a distillation zone, the zone B representing a stripping zone, and the zone C representing a quenching zone, that is, a zone where steam is introduced for the purpose of cooling the coke which falls from the zones A and B. In the zone A, droplets of oil entrained momentarily in the vapors settle or fall back to the stripping zone B, which should be sufficiently elongated to permit an adequate period of time of residence of the oil in said zone to effect substantially complete removal of vaporizable material from the oil. A pitch is formed in the lower part of zone B and enters zone C in the form of a colloid resembling a foam. This coke is cooled by steam or water admitted through branched line 20 controlled by valve 25. This steam may be a wet steam at a temperature of about 212° to 300° F., and the amount of steam added should be about 10% to 20% by weight based on the original feed. Water at atmospheric temperature and in equivalent amount may be substituted for the steam. The average temperature maintained in the drum during the flash coking operation is about 850° F., and the pressure about 5 to 50 lbs. per square inch gauge. The droplets of oil are, as indicated, reduced to vapors and liquid pitch, which pitch is converted to coke, as the oil proceeds downwardly. The coke obtained at the discharge end of the drum is withdrawn through conduit 21 and star feeder 22. This coke is spongy and brittle. Apparently the formation of the spongy coke is associated with the mechanical agitation and stripping of liquid pitch in the drum, that is, a sort of foam is formed in zone C which is converted to a brittle porous solid. The overhead vapors resulting from the coking operation are withdrawn through line 30 and these may be transferred to a cracking or other converting operation (not shown).

Referring now in detail to Fig. II, the fresh feed is introduced into the system through line 31, thence passed into coil 32 located in furnace 33. From there the oil is withdrawn through line 34 and passed into the spray nozzle 35 disposed within and some distance below the top of coking drum 36. Meanwhile, steam from some source is introduced into line 37, then passed through coil 38 located in furnace 39. From there the steam passes through line 40 and line 41 into the spray nozzle 50 located within the drum 36 and spaced apart as shown from spray nozzle 35. The steam which is introduced through line 41 is discharged upwardly against the oil droplets which emerge from spray nozzle 35. A portion of the steam in line 40 may be discharged through line 51, controlled by valve 52, into the pipe 53 where it is admixed with the oil. If desired, 10 per cent by weight of

steam based on the oil may be introduced at this point, but it is preferable to introduce all of the steam through line 41 rather than to mix it with the oil before the passage of the latter through the spray nozzle 35. In this modification a plurality of baffles 60 are disposed in the upper section of drum 36. The oil vapors formed in the drum pass upwardly through this section and a reflux oil, say a gas oil from some source, is introduced at the top of the tower through line 61 and flows downwardly against the rising current of vapors. The oil passing over the baffles 60 serves to condense any high boiling hydrocarbon fractions entrained in the vapors. The resulting condensate then passes downwardly with the reflux oil and is withdrawn from trap-out pan 62 through transfer line 63 and pump 64 and then discharged through line 65 into the oil feed line 34 and thence into the spray nozzle 35. This condensate may advantageously be preheated before entering the oil feed line 34 by discharging it into line 66 and thence into feed line 31.

The oil vapors which are released from the droplets of oil are withdrawn from the drum through line 66. The coke, on the other hand, falls to the bottom of the tower and is eventually withdrawn through star feeder 67 and discharge line 68.

An alternative mode of operation is to substitute flue gas, hydrocarbon gas, or low boiling hydrocarbon oils for the steam specified in the foregoing examples. Whatever gas or vapor is employed should, however, be of such a nature or in such condition as to be free of suspended particles of matter or particles of matter which could coagulate when this fluid medium reaches spray nozzle 15 in Fig. I or nozzle 50 in Fig. II so as not to clog the spray orifices.

While the above concrete example set forth in conjunction with the description of the mode of operation of the apparatus of Fig. I represents the preferred modification of our invention as to operating conditions, it should be pointed out that good results may be obtained by operating within the following range of conditions:

Item 1.—Oil feed rate 0.1 to 2.0 volumes of cold oil per volume of drum per hour.

Item 2.—Temperature of oil feed 850° F. to 975° F.

Item 3.—Steam fed with oil 0% to 10% by weight based on the weight of the oil fed to the drum.

Item 4.—Stripping steam fed to the coking drum, 3% to 40% by weight based on the oil feed.

Item 5.—Temperature of stripping steam fed to the coking drum 850° F. to 975° F.

Item 6.—Temperature of quenching steam 212° F. to 300° F.

Item 7.—Amount of quenching steam 0% to 20%.

Item 8.—Average temperature of coking drum vapors, 800° F. to 950° F.

Item 9.—Average pressure in drum 5 to 50 lbs. per square inch gauge.

It may be pointed out that it is very desirable in our process to spray the oil into the drum in such a manner that none of the oil contacts the walls of the said drum, since this will prevent the deposition of tar, pitch or coke on said walls, and, furthermore, the non-vaporized oil should be separated from the vaporized oil as quickly as possible. While the use of steam gives best results, the steam may be omitted in the case of certain oils.

It will be understood that numerous modifications of the invention may be made without departing from the spirit thereof, and the said invention is not limited to the precise details hereinbefore enumerated but is to be construed as broadly as the appended claims will permit.

What we claim is:

1. The method of coking a reduced crude petroleum oil which comprises heating the said crude to a temperature of 900° F., feeding it in atomized form to a coking zone at a feed rate of 0.5 volume of cold oil per drum volume per hour, feeding to the bottom of the coking zone 20% by weight of steam at a temperature of 900° F., and maintaining an average temperature in the coking zone of about 850° F., withdrawing the vaporous product from the upper end of the coking zone and a spongy, dry coke from the lower end of said zone.

2. The method of continuously reducing a petroleum oil to vaporous fractions and coke, com-

prising heating the oil to a temperature within the range of from about 850° F. to 975° F., feeding it in atomized form to the upper portion of a coking zone at a feed rate of from 0.1 to 2.0 volumes of cold oil per volume of coking zone per hour, where it passes against continuously added, countercurrently moving, superheated steam present in said zone in an amount of from 3% to 40% by weight of the oil while maintaining a pressure of from about 5 to 50 lbs. and an average temperature of from about 800° F. to 950° F. within said zone, withdrawing vaporous fractions from one end of said zone and a frangible coke from the other end of said zone.

3. The method set forth in claim 2, in which the steam is added to the zone at a temperature which is more elevated than the oil inlet temperature in order to compensate for heat absorbed by the endothermic reaction.

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