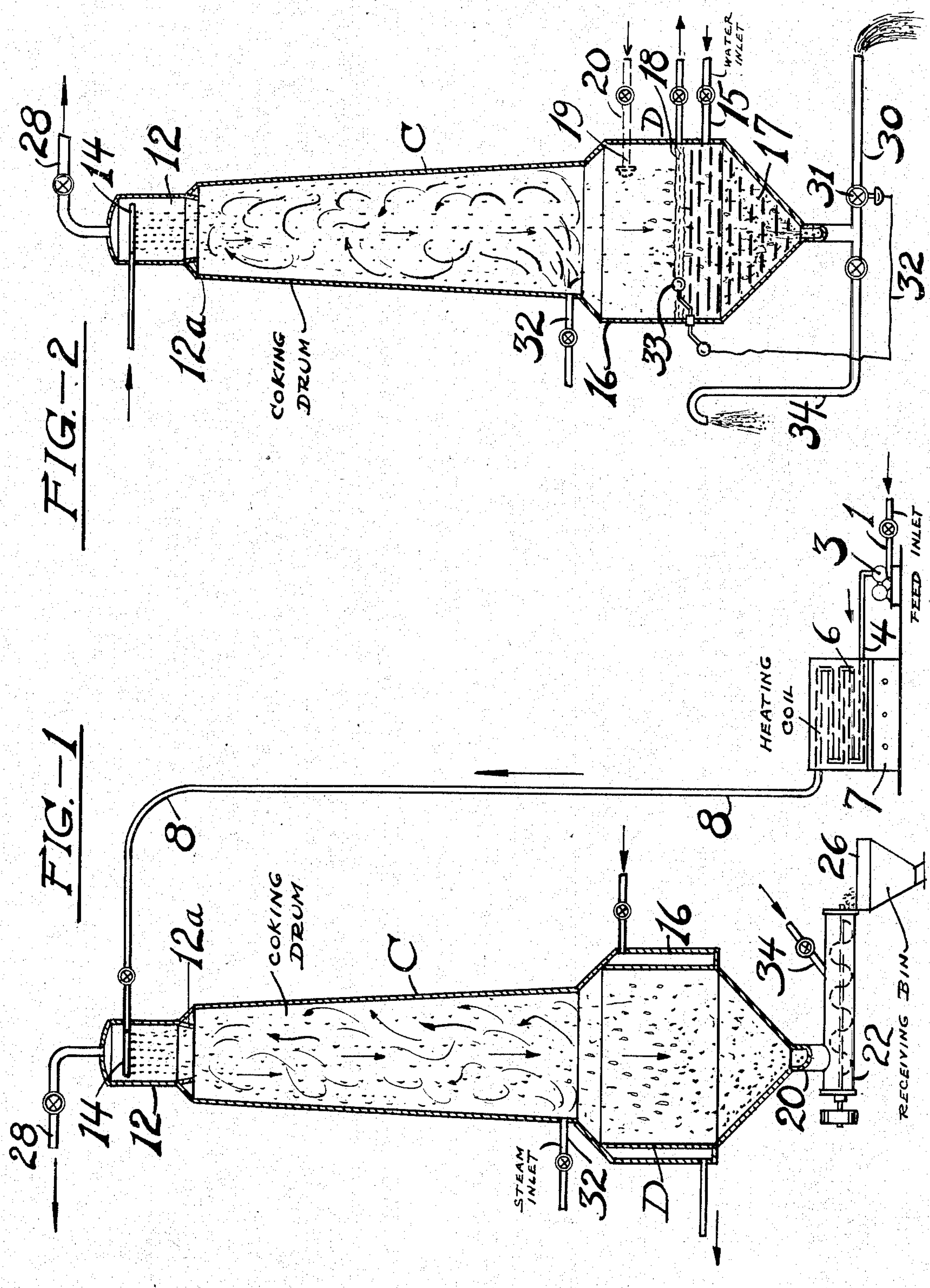
Dec. 26, 1944. F. R. RUSSELL 2,366,057

PROCESS OF COKING HYDROCARBON OIL

Filed Feb. 18, 1941



Francis R. Russell Inventor

By P. L. Young Attorney

Patented Dec. 26, 1944 2,366,057

UNITED STATES PATENT OFFICE

2,366,057

PROCESS OF COKING HYDROCARBON OIL

Francis R. Russell, Elizabeth, N. J., assignor to Standard Oil Development Company, a corporation of Delaware

Application February 18, 1941, Serial No. 379,399

5 Claims. (Cl. 202—8)

The present invention relates to a method of treating hydrocarbons and, more particularly, it relates to a method of coking heavy hydrocarbon oils, such as topped or reduced crude petroleum oils, to produce gas oil, gasoline and coke, some non-condensable or normally gaseous materials being unavoidably also produced.

A great deal of research has been directed toward developing processes for coking heavy hydrocarbon oils in a continuous manner. As is well-known at the present time in the oil industry heavy residual hydrocarbon oils are coked in intermittent processes; that is to say, the oil is heated to coking temperatures and discharged into a drum, usually heat insulated, where it is permitted to remain at coking conditions for a sufficient period of time to effect the desired conversion. These processes result in the formation of considerable quantities of hard adherent coke which clings tenaciously to the walls of the drum. In this type of process, two or more drums are employed, and while the coking operation is taking place in one drum, the other drum or drums are cooled and thereafter workmen remove the coke from the drum usually by operations employing hand tools. The decoking operation is difficult, laborious and time-consuming and, consequently, the oil industry has been continuously seeking means to develop a process which would constitute a distinct advantage over past and present methods. The present invention relates to a method of continuously coking all of the heavy petroleum oil under conditions such that the coke formed in the process is of the "buckshot" type, that is to say, a free-flowing powder-like dry coke which is non-adherent and which may be continuously withdrawn from the drum and, in particular, which coke does not adhere to the drum and form thick layers which would necessitate frequent shutdowns to remove the same.

It is realized that prior to this invention others had devised methods for continuous coking, but these methods have not been entirely successful. Perhaps the most successful methods developed heretofore are those in which a powdered material such as sawdust is sprayed with the oil into the top of an elongated cylindrical coking drum, with the result that the tacky residues, regardless of the volatilizable constituents of the charging stock, are absorbed by the sawdust or other ground solid material.

The present invention, in its essence, involves a process in which a heavy residual oil is preheated to coking temperatures and then discharged in the form of droplets into the top of an elongated coking drum where it is permitted to pass through a hot section to volatilize and crack the volatilizable constituents of the charging stock, leaving a residue of tacky carbonaceous material which passes out of the hot section into a cold section where the hot tacky particles of carbonaceous material are cooled and hardened so that when they finally impinge on the walls of the drum they are non-adherent and free flowing and may be withdrawn by gravity from the bottom of the said drum.

The present invention may be best understood by reference to the accompanying drawing in which

Fig. I shows schematically a coking drum in which my invention may be carried into effect, and in which it will be noted that the coking drum proper is frustro-conical in shape and superimposed upon a cold section of greater diameter than the coking section and carries a water jacket or other cooling means, and;

Fig. II represents a modification thereof in which water or other liquid is used as a cooling medium in the cooling section.

Referring in detail to Fig. I, a heavy residual crude petroleum oil, such as topped crude having an A. P. I. gravity of say 18° and obtained by distilling off the constituents of an East Texas crude oil boiling up to say 825° F., was discharged into the system through line 1, thence discharged into a pump 3, thence discharged into a line 4 and thence discharged into a coil 6 disposed in a furnace setting 7 where the crude oil was heated to a temperature of from about 850° F.–1100° F., the oil being passed through the coil at a sufficient rate of speed to permit only a limited amount of cracking in the said coil, so that no appreciable coke forms in the coil or spray nozzles to be described. This can be accomplished by heating the oil while it flows through tubes of relatively small internal diameter, say from 1 in. to 2 in., with 3 in. as the upper limit, the oil flowing through the tubes at a relatively high velocity. The oil heated to the temperature range indicated was withdrawn from the coil through line 8 and discharged into the top of coking drum 12, the oil in the drum emerging from a spray or atomizing device 14 of conventional design. It will be noted that the coking drum is slightly frustro-conical in shape in the section indicated by C and that it is superimposed on a cold section D, which section has a greater internal diameter than the largest diameter of the hot section C at the point of its greatest diameter. However, section C may be substantially cylindrical. The cold section D carries a cooling jacket 16 adapted to contain cold water, that is to say, a liquid having a temperature of 20° F. or thereabouts, or any other cooling medium. At least a portion of the water may be vaporized and a great cooling effect is obtained by said vaporization. The lower portion or base of the drum 12 is in communication, by means of conduit 20, with a screw conveyor 22, and as will more fully appear hereinafter, the coke delivered to screw conveyor 22 is discharged by the said conveyor into a receiving bin 26 or other suitable receptacle. Any known means for conveying or feeding a solid material may be employed. The volatile constituents resulting from the coking operation are withdrawn overhead from drum 12 through conduit 28, and these constituents may be delivered to condensing and fractionating equipment (not shown) to recover desired constituents.

Referring again to the operation carried out in drum 12 as indicated, the temperature of the incoming oil was about 850° F.–1100° F. and at this temperature was discharged through spray head 14 into the drum in the form of droplets, the orifices in the spray head having a diameter of about 2–15 mm. The pressure maintained within the drum was substantially 1 atmosphere. In order to assist in the general coking operation and, in particular, to facilitate the volatilization of those constituents of the original charging stock which may be readily volatilized, superheated steam, say at a temperature of 1100° F., was discharged into the lower end of the hot section through line 32. This steam had the effect of preventing the diffusion of hot gases into the cold section and tended to cause a general upward current or sweep of volatilizable constituents. The linear velocity, however, of gases, that is to say, the total gases in the hot section upwardly, should not be greater than 10-ft./second, and preferably is of the order of 1–2 ft./second, so that entrainment of oil droplets or tar or coke shall not take place but rather that the said oil particles or tar or coke particles may substantially all pass by gravity through the hot section to the cold section of the said drum. Furthermore, the vapor velocity should be so low that serious turbulence causing impingement of the tacky droplets or particles on the walls of the coking drum will not occur. The oil discharged into the drum through spray head 14 was reduced or "coked" by release of volatile constituents so that at the time when the original oil reached the upper portions of the cold section D it was in the form of tarry adherent droplets or particles. During the passage of these droplets or particles through the cold section they were chilled and hardened and in this form they were discharged from the drum through line 20 into conveyor 22 and from there into bin 26. In order to prevent the escape of vapors from the coking zone, it is advisable to cause a gas, such as flue gas, CO_2, steam, etc., to flow countercurrent to the coke within the casing of conveyor 22, this gas being discharged into said casing through valved line 34. Of course, it is obvious that instead of using a conveyor, the "buckshot" coke may be discharged from the drum through a star conveyor or any other device into a receiving bin.

In the preceding description, it will be noted that, due to the particular shape of the top section 12, there is little or no tendency for sticky lumps or particles of tarry material or coke to cling or adhere to the inner walls of the said section, since the walls of the latter recede outwardly. By provision of lip 12—*a* further security against liquid issuing from spray nozzle 14 contacting the walls of the drum is obtained. Were it not for the said lip eddy current or the like might cause some liquid to be blown against the walls of the drum.

In Fig. II reference characters similar to those in Fig. I apply to similar parts.

It will be noted that in this modification, oil is preheated and sprayed into hot section C as in the prior modification. The coke formed, however, gravitates into a water sump 17 which may or may not be coated with a layer of oil 18. The water is at ordinary atmospheric temperature or at least below about 212° F. and it acts to chill and harden the coke and render it non-adhesive.

Optionally, water from pipe 20 may be discharged into the space above the liquid 17 or 18 to subject the coke to a preliminary cooling. Thereafter, the coke passes downwardly through the oil and water 18 and 17 and is withdrawn through gate valve 31 and pipe 30 in the form of a coke and water slurry. Preferably, valve 31 is operated responsive to float 33 through relay electrical circuit 32 or some equivalent motivating means, in order, if desired, to maintain water discharged through inlet 15 into water 17 at some predetermined level. Another method of maintaining the water 17 at a substantially constant level is to provide pipe 34 with a horizontal bend or portion positioned at about the desired vertical level of water 17, whereupon a coke slurry may be withdrawn continuously from the discharge end of the pipe 34.

Any liquid, such as hydrocarbon oil, brine solution, etc., may be used in place of water.

Many modifications of my invention will be apparent to those skilled in this art without departing from the spirit thereof.

What I claim is:

1. A continuous method for coking heavy residual hydrocarbon oils which comprises heating the said oils to coking temperatures, discharging the said preheated oil into the top of a coking zone, the said coking zone being frustro-conical in shape and having its largest diameter at the bottom thereof, causing the oil to flow substantially straight down aided by gravity through the coking zone in a path whose diameter is substantially less than that of the said coking zone and which path is substantially concentric with the coking zone where volatilizable constituents are formed and removed from the coking zone leaving a residue of coke, causing the coke to pass through a cooling zone where it is dried and hardened, and continuously recovering a free-flowing non-adherent coke from the bottom of said coking zone.

2. A continuous method for coking reduced crude petroleum oil which comprises heating the oil to a temperature within the range of from about 850° F. to 1100° F. in a preheating zone, withdrawing the oil from the preheating zone and discharging it into the top of a vertical frustro-conical coking zone, which zone is of greater diameter at the lower end, causing the oil to flow substantially straight down in a path substantially concentric with the coking zone and of substantially smaller diam-

eter than the smallest diameter of the said coking zone, through the coking zone where volatilizable constituents are removed from the oil leaving a coke residue, thereafter permitting the coke to pass through a cooling zone and continuously withdrawing the coke from the said cooling zone.

3. The process set forth in claim 2 in which the cooling medium is a liquid material which is in indirect heat-exchange relation with the coke.

4. The process set forth in claim 2 in which the cooling medium is a liquid in direct contact with the coke to be cooled.

5. The process set forth in claim 2 in which extraneous superheated steam is employed in the coking section to aid the volatilization of the lighter hydrocarbons.

FRANCIS R. RUSSELL.