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E. C. HERTHEL ET AL

ART OF CRACKING HYDROCARBONS

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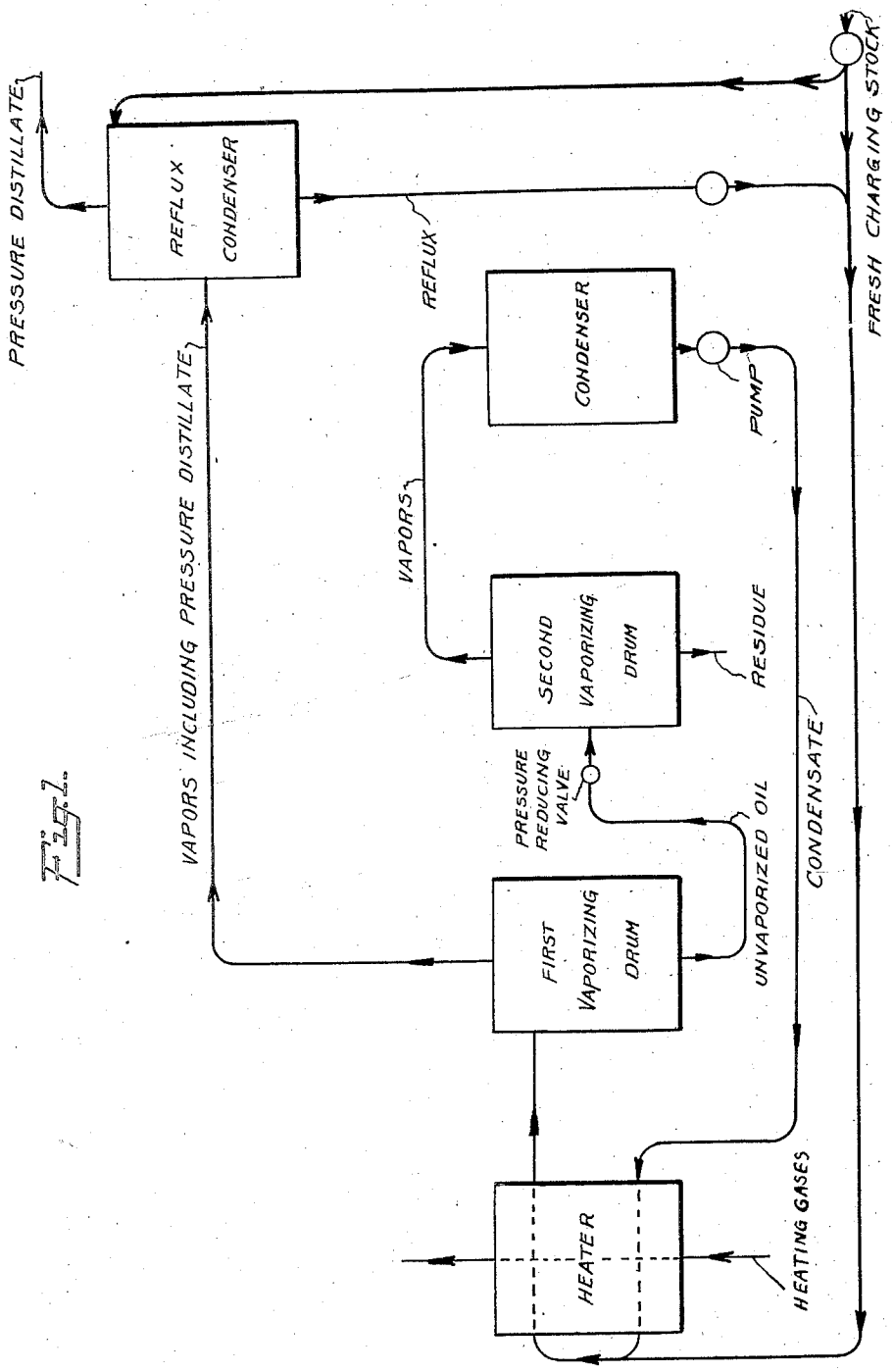


Fig. 1.

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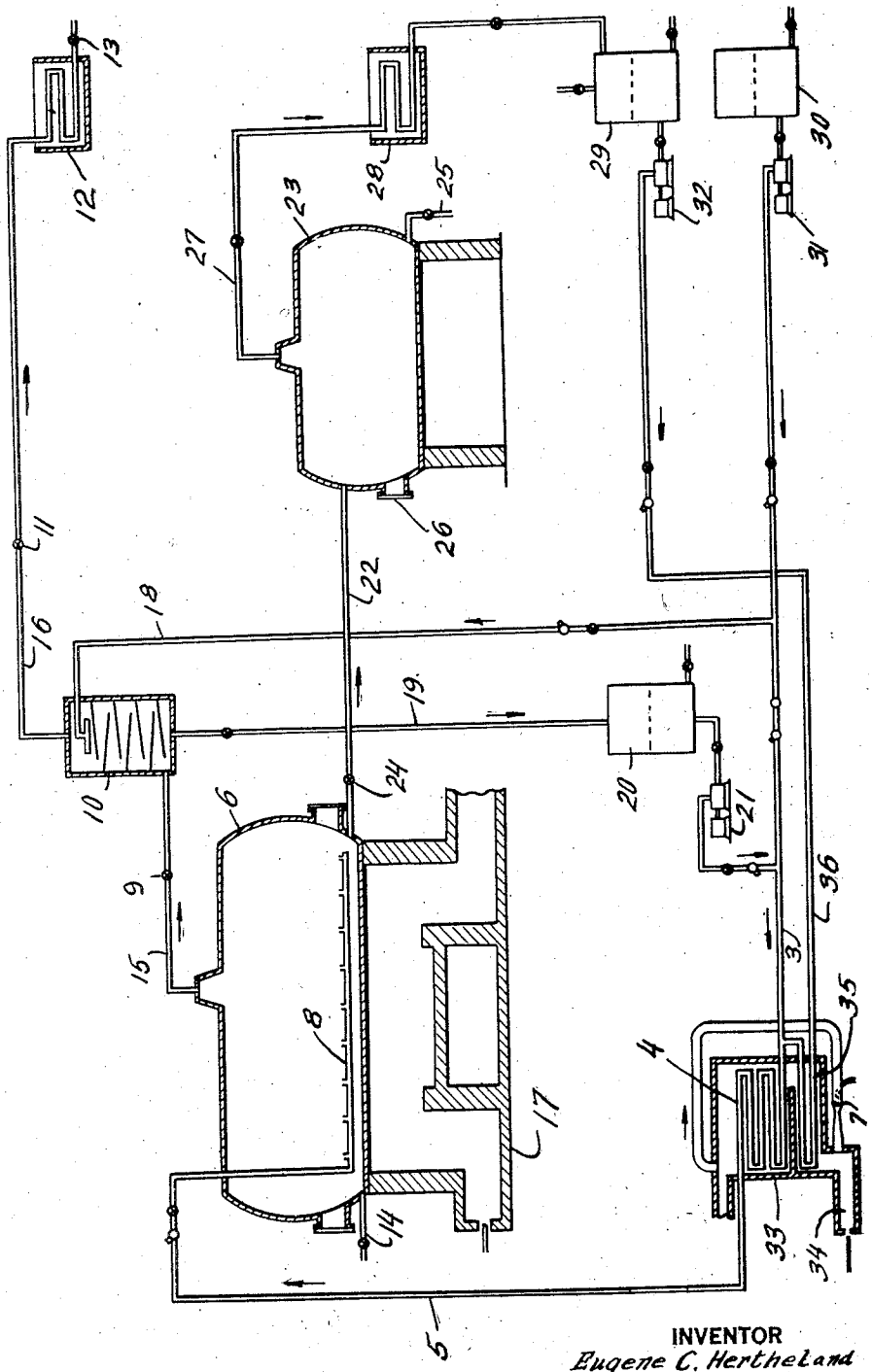


Fig.2.

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UNITED STATES PATENT OFFICE.

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ART OF CRACKING HYDROCARBONS.

Application filed June 22, 1926. Serial No. 117,696.

Our invention comprises an improved method of treating higher boiling hydrocarbon oils, such for example as gas oil, fuel oil, and topped crude oil, to produce therefrom lower boiling hydrocarbon oils, such for example as gasoline and pressure distillate.

In carrying out the process of our invention, the fresh higher boiling hydrocarbon oil to be treated is forced in a single pass through a heating zone in heat exchange with heating gases, such as the hot products of combustion from a furnace in which fuel is burned, by which it is heated to a cracking temperature and is then discharged into a vaporizing zone, being maintained under a superatmospheric pressure in both the heating zone and the vaporizing zone. In this vaporizing zone, a part of the oil including vapors of the desired lower boiling hydrocarbon oils is separated from the unvaporized components of the oil discharged from the heating zone and these vapors are taken off and subjected to appropriate treatment for the separation of the desired fraction or fractions. They may, for example, be subjected to a refluxing operation for the separation of heavier components which heavier components may again be passed through the heating zone, the vapors escaping from the refluxing operation being subjected to condensation to form a pressure distillate. The unvaporized oil collecting in this vaporizing zone, the primary vaporizing zone, is withdrawn as a liquid therefrom and discharged into a secondary vaporizing zone which is maintained under a pressure lower than that prevailing in the primary vaporizing zone. Due to the reduction in pressure, a further separation of vapors is effected in the secondary vaporizing zone and these vapors are taken off and condensed forming a condensate heavier than that produced from the vapors separated in the primary vaporizing zone. The unvaporized residue resulting from the secondary vaporizing operation is not returned to the heating zone. The condensate formed from the vapors separated from the secondary vaporizing zone, however, is returned, in whole or in part, to the heating zone, being forced therethrough first in heat exchange with the heating gases before they are brought into heat exchange with the fresh oil and then being admixed with the fresh oil and passed through the heating zone therewith in heat exchange with the heating gases tempered by the absorption of heat therefrom in this condensate where the heating gases are first brought into heat exchange with it.

In carrying out the invention, it is advantageous to take off as vapors from the primary vaporizing zone, or, if these vapors are subjected to a refluxing operation, as vapors from the refluxing operation, a restricted proportion of the oil, say not more than 40 to 45% or better about 35% of the oil forced into the vaporizing chamber, exclusive of reflux. In the second vaporizing zone, the unvaporized oil is subjected to further vaporization by reduction in pressure, advantageously by means of its self-contained heat, and in this second vaporizing zone as much as 80% or more of the oil may be separated as vapors. Vaporization in the second vaporizing zone may be carried far enough to leave a flux or heavy residue which can be removed as a liquid or it may be carried so far that only coke or a coky mass remains. The vaporization in the second vaporizating zone can be controlled by regulation of the pressure therein. The condensate produced from the vapors separated in the second vaporizing zone is relatively refractory towards further cracking, as compared to fresh oil, and it therefore is with advantage subjected to more severe cracking conditions while at the same time it is with advantage employed to temper the heating gases supplying heat to the operation before they are brought in heat exchange with the fresh oil to prevent overheating or overcracking. The heat absorbed in this refractory oil, in carrying out this invention, is employed in an advantageous way to crack this oil with the production of further quantities of the desired lower boiling hydrocarbons and also, when this oil is admixed with the fresh oil, to assist in heating the fresh oil.

The heating operation may, for example, be carried out in a pipe or tube still arranged so that condensate from the secondary vaporizing operation is circulated first through one battery of pipes or tubes therein and then through a second battery and so that fresh oil is supplied at an intermediate point being passed only through the

second battery of tubes in admixture with the condensate from the vapors produced in the secondary vaporizing operation, heating gases being passed first over the battery of tubes through which this condensate is circulated alone and then through the battery of tubes through which the mixture including the fresh oil is circulated. This pipe or tube still may be arranged to discharge into a drum which in turn may be heated externally or heated internally only by the hot liquid and vapor products discharged into it from the still. From this vaporizing drum, the unvaporized oil may be withdrawn and discharged into a secondary vaporizing drum, the pressure being regulated and reduced between the two vaporizing drums by a manually or automatically controlled pressure reducing valve. This valve may be arranged to operate to maintain a fixed liquid level in the primary vaporizing drum. This secondary vaporizing drum is advantageously externally unheated and lagged or insulated to prevent heat loss so that the secondary vaporization is effected by heat contained in the unvaporized oil from the primary vaporizing drum. Where the vaporization in the secondary vaporizing drum is carried to the point where coke or a coky mass remains, duplicate vaporizing receptacles may be provided so that the operation can be carried out in a continuous manner.

Fig. 1 of the accompanying drawings illustrates pictorially the operation of the process of our invention. We will further describe the invention by reference to an operation in accordance therewith carried out in apparatus of the type diagrammatically illustrated in Fig. 2.

Referring to Fig. 2, fresh oil is forced from connection 3 through the tubes 4 in the heating furnace 33 and is discharged therefrom through connection 5 into drum 6. In the heating furnace 33, heating gases from the fire box 34 pass first over the tubes 35 and then over the tubes 4. To promote the efficiency of the heating furnace, part of the heating gases may be withdrawn from a point near the outlet to the exit flue and returned and admixed with the fresh heating gases from the fire box, as the steam jet blower 7 illustrated. Oil supplied through connection 36 is forced through the heating tube 35 and then in admixture with fresh oil supplied through connection 3 through the heating tubes 4 and into the drum 6. The oil may be brought, for example, to a temperature between 750° and 950° F. in the heating furnace and discharged into the drum 6 at approximately this temperature. The mixed vapors and liquid from the heating furnace may be discharged into a liquid body of oil within the drum 6 through connections such as shown at 8, or this mixture may simply be discharged into the upper part of the drum. The pressure maintained on the drum may be as much as 100 to 200 pound per square inch or more. This pressure may be maintained by appropriate regulating valves located in the discharge lines, may be regulated, for example, by a valve 9 between the vaporizing drum and the reflux condenser 10 or by a valve 11 between the reflux condenser and the final condenser 12 or by a valve 1 beyond the final condenser. A connection is provided at 14 for initially supplying a charge of oil to the drum 6 or for removing residue therefrom. Additional heavy oil may also be supplied to the drum through this connection during the operation to be cracked in the drum. Additional external heat may be supplied to this drum as by the furnace 17 illustrated, or the drum and its contents can be heated internally only by the mixture discharged into the drum from the heater. The drum may with advantage, particularly in the latter type of operation, be lagged or insulated to prevent heat loss.

The vapors separated in the drum 6 escape therefrom through connection 15 to the reflux tower 10. From the reflux tower, the remaining uncondensed vapors including the vapors of the lighter hydrocarbon oils to be produced escape through connection 16 to the condenser 12. Cool fresh oil is introduced through connection 18 into direct contact with the vapors passing through the reflux tower. The refluxing operation can be controlled with advantage by regulating the proportion of cool oil so introduced, and to facilitate such control the reflux tower is advantageously lagged or insulated to prevent heat loss. The reflux produced in the tower admixed with the unvaporized part of the fresh oil introduced into the tower, which fresh oil is heated by contact with the vapors in the tower, passes through connection 19 to the reservoir 20. To promote efficiency, this connection and the reservoir 20 may also be lagged or insulated to prevent heat loss. This mixture, advantageously all of it, is withdrawn from reservoir 20 and forced through the tubes 4 in the heating furnace by means of pump 21.

The unvaporized liquid oil collecting in the drum 6 is discharged therefrom through connection 22 into the drum 23 which is maintained under a lower pressure than that prevailing in drum 6, the pressure on the second drum being reduced and regulated by a valve 24 in connection 22. This drum 23 is lagged or insulated to prevent heat loss and the oil discharged into this drum from drum 6 is partly vaporized therein by its self-contained heat due to the reduction in pressure. The unvaporized residue collecting in this drum, if liquid, is withdrawn through

connection 25, or if solid in nature, is removed through outlet 26. The vapors separated in drum 23 escape through connection 27 to condenser 28 from which condensate is discharged into reservoir 29. The pressure within drum 23 may be substantially atmospheric pressure or a somewhat higher pressure, and the extent to which vaporization is effected therein can be controlled with advantage by regulating the pressure maintained therein. By so regulating the pressure, substantially any desired proportion of the liquid residue discharged into drum 23 from drum 26 can be vaporized to leave either a liquid residue or a solid or semi-solid residue in drum 23. In some cases, a pressure somewhat below atmospheric pressure may be maintained in drum 23, as by suitably arranging the condenser 28. The pressure in drum 23, accordingly, may range from somewhat below atmospheric pressure up to as much as 25 or 50 pounds per square inch or more. Vaporization may also be promoted by injecting steam into the secondary vaporizing zone.

Fresh oil is supplied to the operation from reservoir 30 by means of pump 31. Condensate collecting in reservoir 29 is returned to the operation by means of pump 32, being forced first through the tubes 35 in the heating furnace and then through the tubes 4 in admixture with fresh oil, and reflux. The operation may with advantage be controlled as by regulating the refluxing operation, so that the pressure distillate taken off through connection 16 amounts to not more than 40 to 45%, or better 35%, of the oil supplied from the reservoirs 29 and 30. In the heating furnace 33, the heating gases from the fire box 34 pass first over the tubes 35 and then over the tubes 4, so that the condensate produced from the vapors separated in the secondary vaporizing drum is first brought into heat exchange with the heating gases while they are at highest temperature thereby subjecting this oil to the most severe conditions prevailing in the heating furnace and at the same time tempering the heating gases by the absorption of part of their heat in this oil. In the tubes 4, the fresh oil is thus subjected to less severe conditions and is less liable to be overheated or overcracked, the tubes through which the fesh oil is circulating similarly being protected by this tempering of the heating gases. The oil discharged from the tubes 35 also assist in heating the fresh oil in the tubes 4 by direct heat exchange therewith reducing to this extent the amount of heat necessary to be tranferred through these heating tubes. If, instead of as in the apparatus illustrated where the fresh oil, or part of it, is introduced into direct contact with the vapors from the primary vaporizing zone in the refluxing operation to which they are subjected, this refluxing operation is effected by some other means of cooling, the reflux therefrom particularly where it approaches in character the condensate produced from the vaporization from the secondary vaporizing zone, may be admixed with this condensate and returned through the heater in admixture therewith instead of in admixture with the fresh oil. To promote efficiency, the condensate collecting in reservoir 29 may be cooled only sufficiently to permit it to be handled by a pump so that it can be forced through the heater into the vaporizing drum.

In the operation of a battery of pressure stills for producing lower boiling hydrocarbon oils from higher boiling hydrocarbon oils, a single secondary vaporizing receptacle may be used to handle the unvaporized oil residue from several primary vaporizing receptacles, or the condensate produced from the vapors from one or more such secondary vaporizing operations might be collected in the common receptacle from which various stills in the battery or group might be supplied.

The process of our invention has several important advantages. The period of operation, in accordance with the invention, is materially prolonged by several factors and important operating economies are thereby secured. In the heating furnace, the tubes exposed to the heating gases at highest temperature are protected by circulating therethrough a relatively refractory oil all of which has once been vaporized and which is substantially free from pitch or pitch-like constituents, and the heating tubes through which more easily cracked oil is circulated are protected by the tempering of the heating gases effected by passing them first over the heating tubes through which the refractory oil is circulated. Although the proportion of pressure distillate removed may be relatively restricted, the oil remaining unvaporized, although a preponderating part of the charging stock, is so handled as to effect in an advantageous way a separation of all pitchy or coky constituents which might otherwise interfere with the operation if this unvaporized oil were directly returned to the heating operation, so that the greater portion of the oil remaining unvaporized can be returned to the heating operation for further treatment. This oil free from pitch or coke constituents separated from the residual oil is thus returned directly to the cracking operation and subjected to further treatment therein for the production of further quantities of pressure distillate in a particularly advantageous manner, while unvaporized components of the oil which have once passed through the heating operation and which might interfere with the operation if returned thereto are prevented from again

entering the heating zone. In many cases, this combined operation enables the production of pressure distillate and of the desired lower boiling hydrocarbon oils to be increased by increasing the amount of stock which any particular apparatus can handle in a given time more than enough to make up for the relatively restricted proportion of pressure distillate removed. In any event, the efficiency of the operation is improved by prolonging the period over which the operation can be carried out before it is necessary to shut down the apparatus employed for inspection or cleaning.

We claim:

An improved method of producing lower boiling hydrocarbon oils from higher boiling hydrocarbon oils, which comprises forcing such higher boiling hydrocarbon oils in a single pass through a heating zone into a primary vaporizing zone and maintaining the oil under superatmospheric pressure in both the said heating zone and the primary vaporizing zone, passing unvaporized oil from the primary vaporizing zone to an externally unheated secondary vaporizing zone and maintaining the oil therein under a pressure lower than that prevailing in the primary vaporizing zone, taking off and condensing vapors from the secondary vaporizing zone and forcing oil condensed from these vapors again through the heating zone, first in advance of fresh oil and then in admixture with fresh oil, without returning to the heating zone unvaporized components of oil which have once passed therethrough, passing heating gases in the heating zone first in heat exchange with the oil condensed from vapors from the secondary vaporizing zone and then in heat exchange with the mixture of this oil with fresh oil, and taking off vapors from the primary vaporizing zone including vapors of the desired lower boiling hydrocarbon oils.

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