

Oct. 5, 1926.

1,601,727

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PROCESS AND APPARATUS FOR CRACKING HYDROCARBON OILS

Filed Jan. 15, 1921

2 Sheets-Sheet 1

Fig. 1.

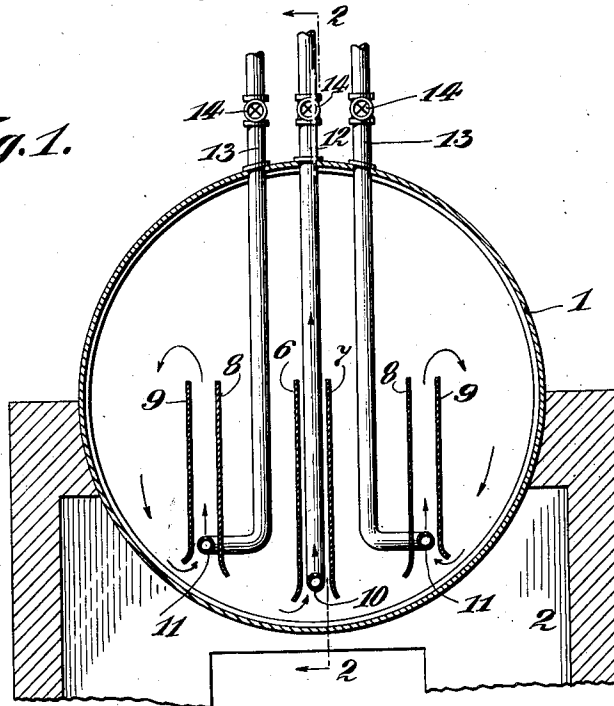
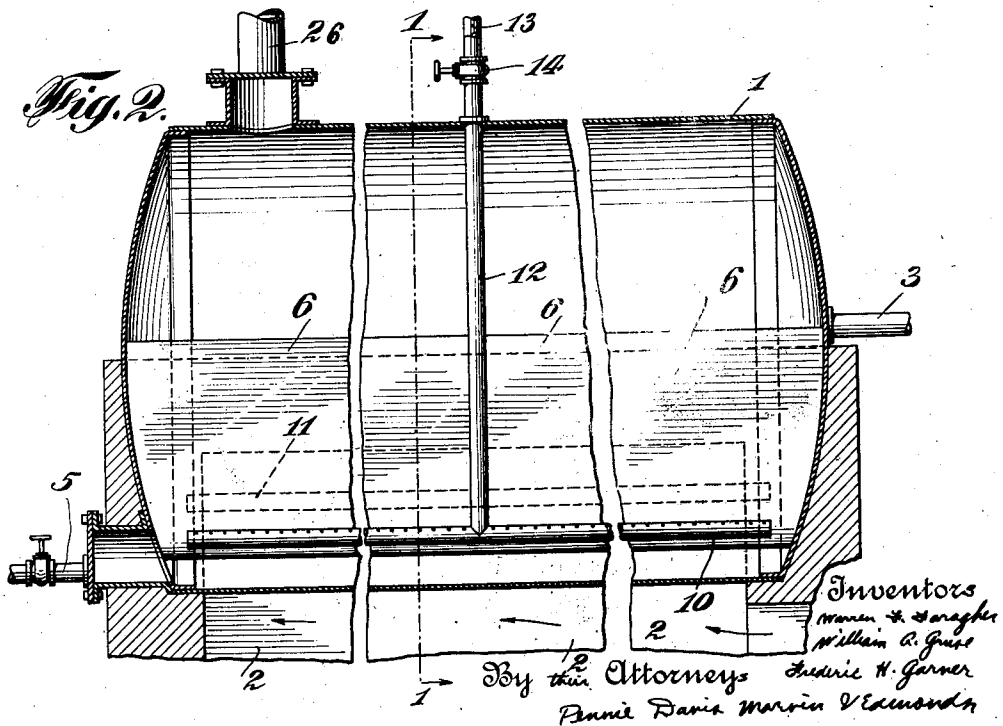


Fig. 2.



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Fig. 3.

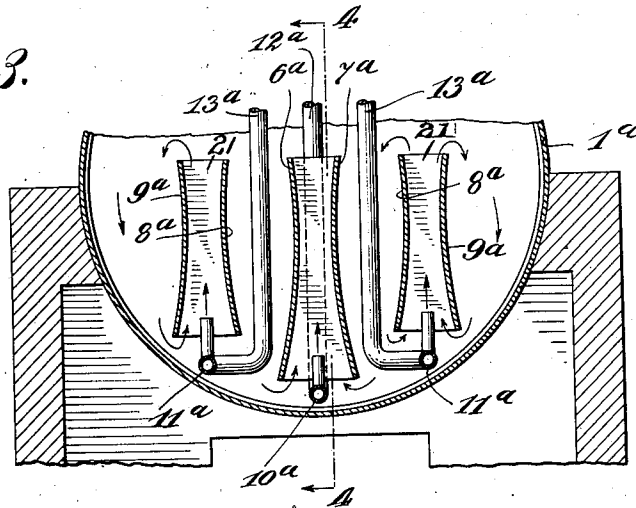


Fig. 4.

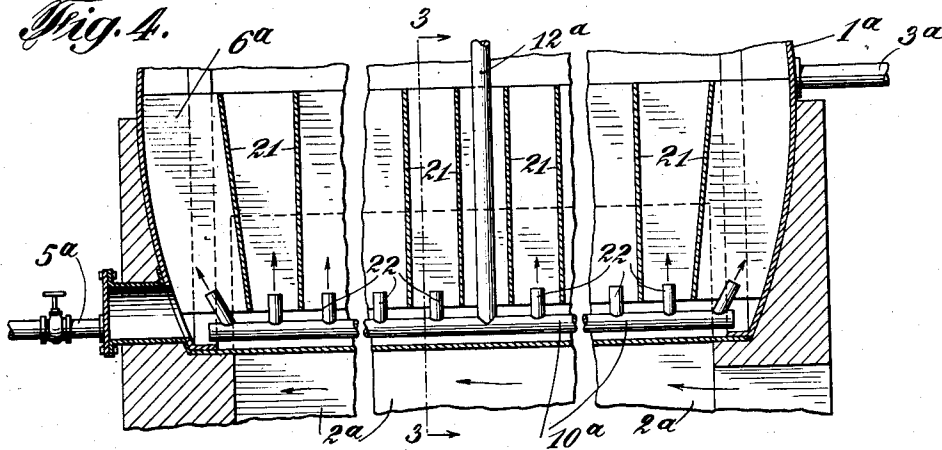
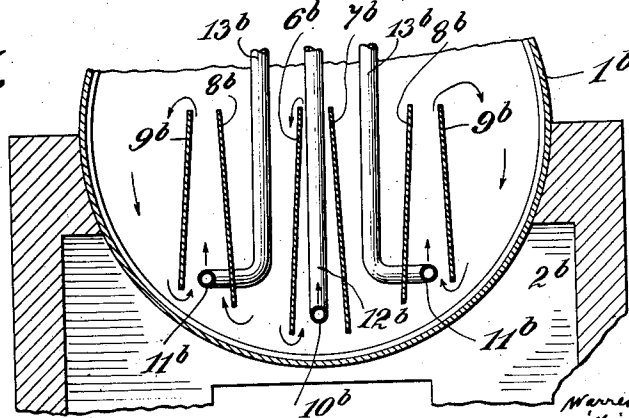


Fig. 5.



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UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR CRACKING HYDROCARBON OILS.

Application filed January 15, 1921. Serial No. 437,481.

This invention relates to an improved method and apparatus for making motor fuel or gasoline by cracking hydrocarbon oils, such as the higher boiling fractions and residual oils of petroleum or shale oil distillation. More particularly, the invention relates to improvements in the cracking of oil in a horizontal cylindrical boiler type of still of the general type referred to in our copending applications Serial Nos. 437,482 and 628,501, which is heated externally to the cracking temperature.

When such oils are subjected to cracking in an externally heated still, serious difficulties are encountered in large-scale operations, due to the depositions of a carbonaceous solid, commonly referred to as "carbon", on the heated walls of the still. Such a deposition of "carbon" interferes with the conduction of heat into the oil, and results in increased cost of gasoline-production owing to the necessity of cleaning the "carbon" from the still walls and the loss of operating time during such cleaning operations; while the life of the still wall is comparatively short due to the rapid burning out of the iron in contact with "carbon".

Attempts have been made to overcome the difficulties mentioned by providing stirrers in the still for agitating the oil, but such stirrers are open to the objection that they require stuffing boxes which must operate against highly heated oil or hot oil vapors at high pressures.

According to the present invention, the cracking operation is carried out in a horizontally arranged cylindrical still, such as is commonly used in cracking oils, but the cracking operation is carried out without objectionable "carbon" deposition and accumulation on the heated bottom of the still, and with avoidance or substantial avoidance of the objections above referred to.

In carrying out the improved cracking operation of the present invention, we provide a plurality of directing baffles, longitudinally arranged in the still, and spaced apart to permit circulation of oil therebetween, and between the baffles and the still

walls, and we maintain an effective circulation of the oil in the still around the baffles and between the baffles and the heated still walls by the introduction of currents of gas between the baffles or between the baffles and the still walls so that the entire body of oil in the still is kept in continuous and effective circulation and heated to a substantially uniform temperature throughout, and so that objectionable "carbon" deposit on the heated bottom of the still will be prevented or removed by the circulating oil. The number of longitudinal baffles provided may vary in shape and arrangement, as well as in number, provided they permit effective circulation of the entire body of oil in the manner above described. This circulation takes place along both sides of the heated bottom of the still, in opposite directions, either toward or away from the central bottom portion of the still; that is, the oil is either circulated from the center of the still, at the bottom, upwardly along the sides of the still, in opposite directions, and back to the central portion of the still after passing between the outer baffles and the still walls, or the oil can be circulated downwardly between the baffles and the still walls, in opposite directions to the center of the still at the bottom, and thence returned upwardly through the central portion of the still for recirculation. Where more than two longitudinal baffles are provided, a series of currents or cycles of the oil will be formed, and the gas jets, in this case, will usually be arranged in the alternate spaces between the directing baffles, so that the oil will have an upward flow through the alternate spaces and a downward flow through the intermediate spaces; while the flow between the outer baffles and the still walls will be either upward or downward, depending upon whether the gaseous current is introduced into these spaces or not. The longitudinal spaces through which the oil flows upwardly may be divided by transverse partitions into a series of passages, in each of which a gas jet or gas jets are arranged, thus giving a

series of "air-lift" spaces; while the intermediate spaces between the baffles, through which the oil has a downward flow, are left open and unobstructed throughout their length.

The invention will be further illustrated and described in connection with the accompanying drawings, which show, in a somewhat conventional and diagrammatic manner; different forms of apparatus embodying the invention, and adapted for the practice of the process of the invention.

In the accompanying drawings, Figs. 1 and 2 show one form of apparatus in vertical, transverse section and vertical, longitudinal section taken along line 1—1 of Fig. 2 and the line 2—2 of Fig. 1, respectively.

Figs. 3 and 4 which are vertical sections along the line 3—3 of Fig. 4 and the line 4—4 of Fig. 3, respectively, show an apparatus with a somewhat modified form and arrangement of directing baffles.

Fig. 5 shows a further modified form and arrangement of directing baffles.

In the apparatus of Figs. 1 and 2, the still 1 is a horizontally arranged cylindrical boiler type of still such as is commonly used in the cracking of oil. It is arranged in a suitable furnace setting so that it is heated either by direct heat or by products of combustion in the furnace chamber 2. The still is provided with a suitable oil supply pipe 3 through which a regulated supply of oil can be introduced either in the form of successive charges or in a more or less continuous manner. The oil supply can be automatically regulated in any suitable manner (not shown), to maintain a constant level in the still. The residue outlet from the still is indicated at 5. The still has a dephlegmating column 26 leading to the vapor pipe and condenser (not shown).

Arranged within the still is a series of six longitudinally arranged baffles, arranged in pairs. The inner pair of baffles 6 and 7 are centrally and symmetrically arranged, while the two outer pairs of baffles 8 and 9 are arranged at equal distances from the center of the still. These baffles are supported in any suitable manner, as by securing them to the heads of the still, and they are spaced apart from the bottom of the still to permit the circulation of oil therebetween. The baffles extend from near the bottom of the still to a considerable height which, in the preferred practice, is such that the upper edges of the baffles are submerged in the oil a sufficient distance to permit free circulation of the oil over them.

Arranged between the baffles of each of the three pairs are perforated gas introduction pipes, the central pipe 10 being arranged between the central baffles 6 and 7, and the outer pipes 11 being arranged between the baffles 8 and 9. Gas is supplied to these

pipes through suitable inlet pipes 12 and 13, having regulating valves 14 therein. The arrangement of the perforated pipes 10 and 11 is such that they discharge gaseous currents into the oil between the baffles, thus decreasing the weight of the body or column of oil between the baffles and causing upward flow of this body of oil. The gas thus introduced acts on the "air-lift" principle, causing upward circulation of the oil between the baffles, and downward circulation of the oil in the spaces between the different pairs of baffles and between the outer baffles 9 and the still walls. That is, the oil is caused to flow downwardly in the alternate spaces between the baffles and between the outer baffles and the still walls, and upwardly in the intermediate spaces, due to the "air-lift" action of the gas jets introduced, so that the oil flows under the lower edges of the baffles, between these baffles and the still walls, and also over the upper edges of the baffles. A series of circulation paths or cycles of oil is thus established and maintained so that the entire body of oil in the still is kept in vigorous and effective agitation and circulation, and so that the oil is kept in circulation over the heated bottom wall of the still and objectionable "carbon" deposition thereby substantially prevented or removed. The lower edges of the baffles cause rapid eddy currents to be formed which have a scouring action upon the still wall, tending to keep it free from "carbon" deposit. The different parts of the body of oil are thus caused to mingle and intermingle in the course of the circulation so that the entire body of oil is heated to approximately the same temperature, with resulting uniformity of the heating action and avoidance of objectionable local overheating, as well as substantial avoidance of a dead layer of oil along the still bottom which has heretofore been the chief cause of "carbon" trouble and deposit.

In the apparatus of Figs. 3 and 4, the still is of the same general construction as that of Figs. 1 and 2, and the same parts are indicated by the same reference characters, with the letter "a" appended thereto. The directing baffles, in Figs. 3 and 4, are somewhat curved, and have a transverse section resembling that of a Venturi tube. So also, in the arrangement of Figs. 3 and 4, a series of transverse partitions 21 may be provided in the longitudinal space between the baffles to divide up this longitudinal space into a series of smaller spaces, extending longitudinally of the still, and each such space is provided with a gas inlet jet or jets, shown as separate branch pipes 22. These branch pipes will discharge the gas upwardly into the individual spaces, giving an individual "air-lift" action in each space. The intermediate spaces between the longi-

tudinal baffles, for the downflow of the oil therethrough, are left open and unobstructed.

In the apparatus of Fig. 5, the general construction and arrangement is similar to that of Fig. 1, and the corresponding parts are indicated by the same reference characters with the letter "b" appended thereto. The directing baffles, however, are somewhat inclined so that they are closer at the top than at the bottom, in order to reduce the speed of gas separation and assist in maintaining the foam in the still.

The gas which is used for bringing about the circulation and stirring of the oil may with advantage be the fixed gas formed during the cracking operation, after the condensible constituents have been removed therefrom in the condenser, but other appropriate gas can be used, such as natural gas or casing-head gas or other gaseous material, such as steam, which has no objectionable effect upon the cracking operation. This fixed gas may be drawn off at the still pressure, where the condenser is maintained under the same pressure as the still as in the preferred practice, or at a lower pressure, where the condenser is maintained at a lower pressure; and it can then be passed through a compressor or gas booster (not shown) for increasing its pressure sufficiently to force it into the still at the desired rate and under the appropriate pressure. Instead of using the fixed gases after condensible constituents have been separated therefrom, a part of the mixed vapors and gases can be drawn off from the vapor line at substantially the still temperature and pressure and recirculated, thus taking advantage of the temperature of these gases as well as their pressure.

The introduction of the gas currents not only serves to insure effective agitation and circulation of the oil, in the manner above described, but it promotes the regular removal of the lower boiling constituents resulting from the cracking operation as they are formed, and prevents their remaining in the still for long periods of time to undergo objectionable decomposition. The excess gas, resulting from the cracking operation and from that introduced, can be discharged from the still in any of the usual ways, or a part reused for reintroduction into the still and the excess discharged from the still or condenser.

In carrying out the process, the oil will be continuously circulated and continuously heated in such a way that the temperature of the body of oil as a whole will be maintained at a generally uniform temperature, with avoidance of objectionable local overheating of the oil next to the still wall, and the temperature of the oil will thus be raised

into that range of temperatures most favorable to the cracking operation with the production of considerable naphtha and gasoline and relatively little gas and carbon, and without objectionable local overheating of the oil to the still higher temperatures at which much gas and "carbon" are formed. This uniformity of temperature of the oil body as a whole is brought about by the continuous and effective circulation of the entire body of oil, with resulting increased uniformity of the cracking operation, while the oil that is heated by its circulation between the baffles and the still walls is continuously removed so that the formation of a "dead layer" of oil is prevented, with resulting prevention of the heating of such a layer to objectionably high temperatures.

It is one advantage of the invention that it brings about an effective circulation of the oil without the use of moving mechanism and therefore without the use of stuffing boxes, so that all connections of the still may be welded and made gas-tight.

Inasmuch as the accumulation of carbon on the still walls is prevented or minimized, the cracking operation can be continued for relatively long periods of time, the oil being supplied continuously through the oil inlet pipe and the residue being removed continuously or periodically through the residue outlet pipe. When a considerable accumulation of "carbon" in suspension in the oil has been brought about, the entire body of residue can be removed and a fresh charge introduced without the necessity of opening the still to clean it of carbon deposit.

It will be understood that the stills are provided with suitable pressure, temperature and level indicating devices (not shown), as well as with means for producing and maintaining within the still the necessary temperature and pressure conditions for the cracking operation. The cracking operation may thus be carried out under the regulated pressure, for example, of between 60 and 500 lbs. per square inch, and preferably in the neighborhood of 75 to 150 lbs. per square inch, depending upon the nature of the oil to be cracked and the products desired. The prevention of objectionable "carbon" deposit on the heated still walls prevents weakening of the walls by overheating, such as results when the bottom wall of the still becomes incrustated with a thick layer of "carbon" deposit or coke.

Owing to the continuous circulation and substantially uniform temperature of the entire oil body, the cracking operation is improved, with high yields of gasoline and lower gas and coke losses, and hence in-

creased capacity or improved yields for a given sized still, while the effective life of the still is at the same time very materially increased.

5 The oil feed to the still may be preheated to a greater or less extent before it enters the still. A part of the necessary heat can be supplied by means of a heat interchanger through which the still "bottoms" are discharged; while a part of the preheating can be effected by bringing the oil into heat
10 interchanging relations with the hot vapors from the still, thereby making the heat of these vapors available in the preheating operation. The oil feed can, for example, be passed through the condenser for the vapors from the still, or through one or more of the series of such condensers, where such a series is used for cooling and con-
15 densing the vapors. The preheating effect thus secured, may be supplemented, if desired, by further preheating of the oil feed in any suitable manner, and the preheating of the oil can advantageously be carried to
20 such a degree as to vaporize and remove any water present therein before the oil enters the still.

In illustrating the various forms of apparatus in the accompanying drawings, we
25 have omitted the heat insulation or lagging of the still, connecting pipes, etc., but it will be understood that, in practice, suitable heat insulation will be provided to avoid objectional losses from all exposed parts of the still and of the system which become
30 heated.

From the foregoing description it will be seen that the improved method and apparatus of the present invention, enable the
35 cracking operation to be carried out in an improved and advantageous manner, with effective agitation and circulation of the entire body of oil in the still, and with resulting uniformity of temperature and of
40 cracking, as well as with effective circulation of the oil over the heated bottom of the still and the prevention of the formation of a "dead layer" of oil and objectionable "carbon" deposit on the heated still walls,
45 this circulation of the oil being effected between longitudinally arranged baffles and between such baffles and the still walls, in a cyclic manner, so that the oil is caused to flow upwardly or downwardly
50 along the side walls of the still, in opposite directions, either toward or away from the center of the still at the bottom, while the entire body of oil is kept in circulation around the baffles in such a way
55 that all parts of the oil are effectively agitated and circulated.

In referring to the cracking of "oil" in the present specification and claims, we intend to include the treatment of various
60 hydrocarbon oils, and more particularly the

treatment of higher boiling fractions and residual oils of petroleum or shale oil distillation, for the production of motor fuel or gasoline; but other oils, such as lignite or coal tar or tar oils, etc., can be similarly
65 treated; and we include all such materials within the term "oil", as used in the accompanying claims.

It is to be understood that a plurality of stills of the designs disclosed in this specification may be arranged in series and the oil to be cracked passed through them consecutively.

We claim:—

1. The method of cracking oils which
70 comprises heating a body of oil in a still to a cracking temperature by the external application of heat to the still, sub-dividing the main body of oil in the still into a plurality of vertically disposed smaller bodies
75 freely communicating at their upper and lower ends respectively, and causing circulation of the oil in the still in a plurality of paths or cycles by introducing upwardly
80 flowing gaseous currents acting on the "air-lift" principle into some but not all of the sub-divided smaller bodies near the lower end thereof.

2. The method of cracking oils which
85 comprises heating a body of oil in a still to a cracking temperature by the external application of heat to the still, sub-dividing the main body of oil in the still into a plurality of vertically disposed smaller bodies
90 freely communicating at their upper and lower ends respectively, and causing circulation of the oil in the still in a plurality of paths or cycles by introducing upwardly
95 flowing gaseous currents acting on the "air-lift" principle into alternates of the sub-divided smaller bodies near the lower end thereof.

3. An apparatus for cracking oils, comprising a horizontally arranged still, means for heating said still externally, a plurality of vertically arranged longitudinal baffles
100 in said still spaced apart from each other and from the still walls, and means for introducing a plurality of gaseous currents, acting on the "air-lift" principle, into alternate passages between said baffles for effecting
105 circulation of the oil.

4. An apparatus for cracking oils, comprising a horizontally arranged still, means for heating said still externally, a plurality of vertically arranged baffles in said still
110 spaced apart from each other and from the still walls, and means for introducing upwardly flowing gaseous currents, acting on the "air-lift" principle into alternate passages between the baffles for bringing about
115 the circulation of the oil in a plurality of different paths between the baffles and between the baffles and the still walls.

5. An apparatus for cracking oils, com-
120 125 130

prising a horizontally arranged still and means for heating said still externally, a series of vertically arranged longitudinal baffles in the still spaced apart from each other and from the still walls, said baffles being arranged below the normal liquid level in the still bottom, and means for introducing gaseous currents between alternate baffles, whereby circulation of the oil is effected around the baffles and between the baffles and the still walls in a plurality of different paths or circuits.

In testimony whereof we affix our signatures.

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