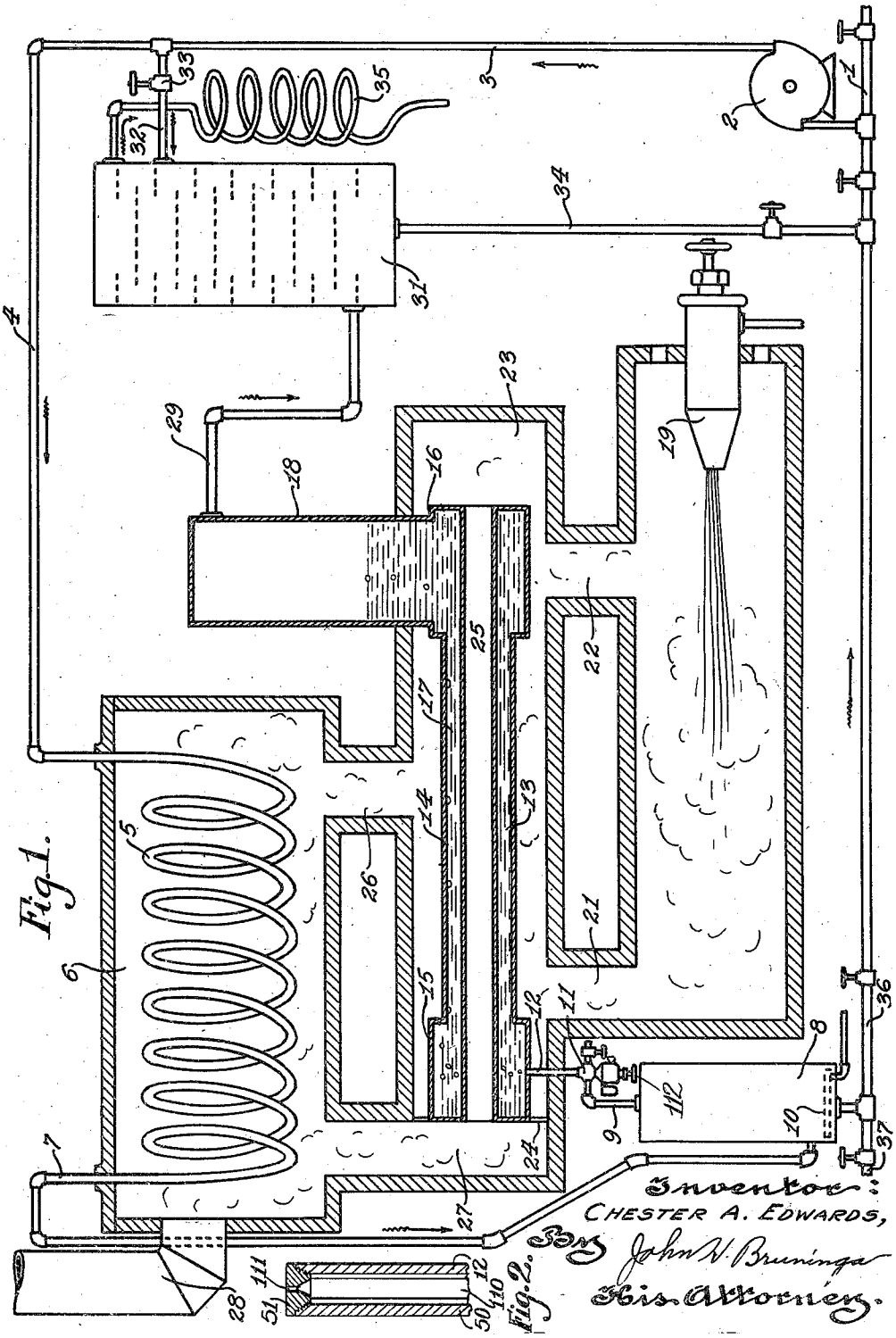
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APPARATUS FOR TREATING PETROLEUM

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APPARATUS FOR TREATING PETROLEUM

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This invention relates generally to the treatment of petroleum and particularly to a process and apparatus for pyrogenic decomposition of petroleum by subjecting the same to the action of a fused metal column.

Various efforts have heretofore been made to pyrogenically decompose petroleum in order to increase the yield of the lighter and more valuable hydrocarbons from the heavier and less valuable components and in connection with the various efforts along this line it has many times been attempted to employ a bath of fused metal as the heating medium for the petroleum. Many objections have arisen in the use of such fused metal baths for the treatment of petroleum and outstanding among these is the tendency for the fused metal, such as lead, to become contaminated, not only by the impurities from the petroleum but also by the free carbon which is liberated upon cracking of the petroleum in the formation of lighter saturated and unsaturated hydrocarbons. It has heretofore been difficult when fused metallic baths have been employed as the heating medium in cracking processes to maintain the petroleum in contact with the fused metal for a period of time sufficient to bring about the desired cracking and accordingly in order to obtain the maximum yield of the lighter valuable hydrocarbons such as those which go to form gasolene, it has been necessary to re-run and re-circulate the residuum and heavier condensates many times before the maximum gasolene yield is obtained.

The object of this invention generally stated is to provide a process and apparatus for cracking petroleum employing a fused metallic bath and to so regulate the flow of petroleum through the bath that the maximum cracking is accomplished.

A further object of this invention is to provide a process and apparatus for treating petroleum in which contamination of a fused metallic bath is avoided.

Another object of this invention is to provide a process and apparatus of treating petroleum in which the heavier components are separated from the vapors which are to be contacted with a fused metal bath.

A more specific object of this invention is to provide an apparatus for treating petroleum employing a fused metallic bath and so constructed and arranged as to attain the maximum heat efficiency.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawing, in which:

Figure 1 is a view somewhat diagrammatic in form illustrating generally the relative position of the various pieces of apparatus employed in the process of the present invention and particularly the heating arrangement for the contact chamber, which is shown in sectional side elevation.

Figure 2 is a detail view of a needle valve employed in the apparatus shown in Figure 1.

In accordance with the present invention, one embodiment of which is illustrated in the accompanying drawing, the petroleum to be treated is preferably first preheated under pressure to an extent such that the lighter components will be vaporized. The vapors thus obtained are then introduced into the presence of a bath of molten metal, such as for instance lead, which is preferably heated to a temperature sufficient to accomplish pyrogenic decomposition of the petroleum vapors. In accordance with the present invention, the chamber containing the metallic bath is preferably arranged so as to impede the flow of petroleum vapors therethrough and in accordance with the embodiment illustrated in the accompanying drawing the chamber is disposed in a substantially horizontal position so that the petroleum is caused to move in a lateral direction between the point of delivery to the bath and the point of exit therefrom. When the petroleum, which may be either a preheated liquid or a vapor, is thus caused to move in a lateral direction, it is apparent that the rate of movement of the petroleum is considerably less than when it is permitted to move in a vertical direction and accordingly the period of contact between the molten metal and the petroleum under treatment is substantially prolonged so that the maximum cracking is accomplished and a greater yield of lighter hydrocarbons is obtained than would otherwise be possible.

Referring now particularly to the drawing, illustrating one embodiment of the present invention, the petroleum to be treated, which may be either a natural crude or a fuel oil, that is a petroleum from which the lighter hydrocarbons have been previously stripped, may be conveyed from a suitable source of supply through a pipe 1 and delivered to a pump 2 for maintaining pressure upon the petroleum throughout the process. From the pump 2 the petroleum to be treated is delivered to a pipe 3 and conveyed by means of a pipe 4 to a petroleum heater, which in the embodiment illustrated in the ac-

companying drawing, is shown as a coil 5 comprising the desired number of turns and disposed in a chamber 6 for contact with hot flue gases in a manner to be later described. The temperature of the chamber 6 may be regulated by suitably controlling the flow of flue gases therethrough in order that the petroleum in the coil 5 may be preheated to the desired extent, it being understood that the heating arrangement is preferably so arranged that as the petroleum moves from right to left, as seen in the drawing, it gradually becomes hotter until the desired temperature, which may be for instance 600° to 700° F. is attained. From the heating coil 5, the preheated petroleum is conducted through a pipe such as 7 to a suitable expansion tank 8, it being understood that the natural resistance of the pipe 7 to the flow of petroleum therethrough is generally sufficient to create the necessary pressure differential between the expansion tank 8 and the coil 5 so that the lighter components will be vaporized upon reaching the tank 8. It is, however, to be distinctly understood that suitable pressure relief valves may be provided in the line 7 in order to maintain the desired pressure differential between the expansion tank 8 and the heating coil 5. Upon reaching the expansion tank 8, the lighter components of the preheated petroleum will be vaporized, while the heavier components, such as for instance those which go to form fuel oil will settle as a liquid in the bottom of the tank 8 to be disposed of in a manner later to be described. It will be understood, however, that in lieu of such a heating coil 5 and an expansion tank 8, a suitable batch still may be employed. In order to reduce the vapor tension and facilitate vaporization of the lighter fractions in expansion tank 8, a supply of steam may, in accordance with the usual practice be supplied thereto by a series of jets 10.

The vapors of the lighter components may be conducted through a pipe 9 to a valve 11, which may, if desired, automatically operate to control the flow of vapors through a delivery tube 12 for delivery into the fused metallic bath. The valve 11 is preferably of the needle type and may be of any well known construction, such as for instance that illustrated in Figure 2 in which a needle 110 extends through delivery tube 12 and seats against a seat 111 adjacent the end thereof. The valve opening may be regulated by manipulation of handle 112.

In accordance with the present invention, the chamber which contains the fused metal, to which the petroleum is to be exposed is preferably tubular in form, as illustrated at 13, it being understood, however, that the chamber 13 may be of any desired shape and dimensions, preferably extending in a substantially horizontal direction and of such length as to cause the petroleum delivered thereto from the delivery tube 12 to move a substantial distance in contact with the molten metal therein. In the embodiment illustrated in the drawing, the chamber 13 is provided with a main portion 14, having a substantially uniform cross-sectional area and extending in a substantially horizontal direction. At each end of the main portion 14, portions 15 and 16, having a larger cross-sectional area are provided and it is apparent from the drawing that the delivery tube 12 communicates with the chamber 13 in the region of the enlarged portion 15. The chamber 13 is, as heretofore pointed out, adapted to contain a column of molten metal 17, which may be for instance lead, completely filling the main portion 14 of the chamber 13 and extending into the enlarged portions 15 and 16. Connected with the enlarged portion 16 is a sleeve 18 extending substantially vertical as a stack and suitable openings may be provided in the sleeve 18 for initially filling the chamber 13 with lead. As illustrated in the accompanying drawing the lead 17 preferably extends for a distance up into the sleeve 18, as well as for a distance up into the enlarged portion 15 so that the enlarged portions 15 and 16 form in effect risers to permit the expansion of lead in that region. When the chamber 13 is initially filled from the sleeve 18, however, with the device in the position illustrated in the accompanying drawing, it is apparent that a small amount of gas will be entrapped in the enlarged portion 15 above the level of the lead in the main portion 14. Accordingly the unoccupied space in the enlarged portion 15 above the level of the lead therein permits expansion of the lead in that end of the chamber upon reheating, should that end become heated to the melting point of lead, or any other metal employed, before the metal in the enlarged portion 16 is melted so that the expansion could be accommodated in the sleeve 18. It is apparent, therefore, that the enlarged portions 15 and 16 each operate to accommodate the lead upon expansion thereof when the chamber is initially heated.

In accordance with the present invention the chamber 13 is mounted for contact with the gases of combustion from a suitable burner, such as 19, which may be supplied with fuel oil or fixed gases resulting from the process. In order to accomplish this a casing may be provided about chamber 13 and burner 19 so that the gases of combustion may be directed from the burner through openings 21, 22 into a heating chamber 23 surrounding the chamber 13 and in accordance with the present invention the space between the inside wall of the heating chamber 13 and the outside wall of the enlarged portion 15 of the chamber 13 is preferably sealed off by a wall 24. Accordingly the gases of combustion emerge from the heating chamber 23 through a tube 25 extending lengthwise through the chamber 13 so that the molten metal contained within the chamber 13 is heated not only from the exterior of the chamber but also from the interior of tube 25. Some of the gases from the heating chamber 23 may pass through an opening 26 to the heating chamber 6 surrounding the coil 5, while the remainder thereof passes through tube 25, stack 27 and into the heating chamber 6 from whence they are ultimately delivered to stack 28. It will be understood that suitable dampers may be provided for regulating the flow of the flue gases from the burner 19 through the heating chambers 23 and 6 in order that the temperatures may be regulated as desired. For instance in operation, it will generally be desired to maintain the temperature of the metal bath in the chamber 13 at between 800° and 1100° F. depending upon the nature of the petroleum to be treated, while at the same time the temperature of the petroleum heater, such as coil 5, will be maintained at between 600° and 700° F.

When the petroleum vapors from the delivery tube 12 are delivered to the chamber 13, it is apparent that the tendency will be for these vapors to rise directly from the surface of the molten metal 17 in the chamber 13 and so will

accumulate in the space existing above the surface of the molten metal in the enlarged end 15. It will be observed, however, that the space in which the vapors are confined in the enlarged end 15 is relatively small so that the vapors are maintained in close contact with the fused metal column. When, however, sufficient vapors have been accumulated in the enlarged end 15 to force the molten metal downwardly to the level at which it exists in the main portion 14, it is apparent that the vapor bubbles will begin to travel to the right toward the sleeve 18. During the travel of the vapors laterally through the main portion 14 it is apparent that the movement thereof will be relatively slow due to the fact that they will be confined between the molten metal and the outer wall of the chamber 13, being at all times subjected, at least to a pressure corresponding to the weight of the molten metal column above the level thereof. It is apparent, therefore, that during the retarded movement of the vapor bubbles laterally through the main portion 14 that the heat of the lead column, being preferably between 800° and 1100° F., will be such as to accomplish the maximum cracking and accordingly the yield of lighter hydrocarbons will be increased. During this cracking, however, as is well known, some free carbon is liberated, which in the process of the present invention, due possibly to the fact that the vapor bubbles tend to move individually through the bath, is carried along with and up into the sleeve 18. When the vapor bubbles have moved laterally for a sufficient distance to bring them into the region of the enlarged portion 16, it is apparent that they will rise rapidly to the surface, and having undergone a pyrogenic decomposition resulting in the formation of the lighter hydrocarbons and free carbon, will escape from the surface of the molten metal and collect in the sleeve 18. An outlet 29 communicates with the sleeve 18 above the level of the molten metal and operates to convey the cracked vapors and the free carbon carried thereby to a suitable reflux condenser 31 which may be of any suitable well known construction. As the cracked vapors from the chamber 13 flow upwardly through the reflux condenser 31 they will encounter a stream of petroleum or fuel oil to be later treated and which may be supplied to the condenser 31 from the pipe 3 through a pipe 32 suitably controlled as by a valve 33. In the reflux condenser 31, the higher boiling point components may be condensed and carried on with the reflux being conducted from the condenser 31 to a pipe 34 from whence they may be delivered to the pump 2 for supply to the petroleum heater 5. The vapors which pass through the reflux condenser 31 may be delivered to a suitable condenser 35, fractionating condensers and the like for obtaining the various products.

It will be understood that the liquid obtained from the expansion tank 8 may be delivered to a suitable pipe 36 by which it may be conducted to the pump 2 for recirculation through the system or may be conducted through a pipe 37 to a suitable oil storage tank from which it may be fed to the burner 19 for combustion.

Although in the foregoing description certain theories of operation have been advanced, principally with reference to the action of the petroleum vapors within the chamber 13 and the effect of the lateral movement therein upon the vapors, this has been done merely to facilitate the disclosure, and it is to be distinctly understood that the invention is not limited to any theoretical consideration nor even to that theory which has, for the purpose of illustration, been referred to hereinbefore. In the actual operation of the process of this invention, a high yield of those hydrocarbons which go to form gasolene is obtained and a feature of particular importance is the fact that as the vapors pass through the metal bath within the chamber 13 the free carbon liberated during the cracking is carried off by the vapors and collected with the pressure distillate from the condenser 35. In passing through the metal bath, the vapors not only carry with them that free carbon which is liberated on cracking, but also any other impurities which may have been delivered, so that contamination of the lead within the chamber 13 is avoided.

As an illustration of the practical operation of the process of this invention a crude from Sommerset County, Kentucky, yielded 30% natural gasoline (without cracking) which when tested was found to have an "octane number" of 49. The same crude, however, when treated in accordance with the process of this invention showed a gasoline yield of 45% having an "octane number" of 68. It is apparent, therefore, that cracked gasoline produced in accordance with this invention is far superior to natural gasoline from any chosen crude.

From the foregoing description, it will be apparent that many modifications of the invention hereinbefore described and set forth in the accompanying drawing, will present themselves to those skilled in the art and will not depart from the spirit of this invention. It is to be distinctly understood, therefore, that the invention is not limited to the specific details which have been hereinbefore set forth and illustrated in the accompanying drawing, and that such modifications and the use of such individual features and sub-combinations of features as do not depart from the spirit of this invention are, although not specifically described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. An apparatus for treating petroleum comprising, a tubular chamber extending substantially horizontally and adapted to contain molten metal, said chamber having a main portion adapted to be completely filled with molten metal and end portions rising above the level of the metal in the main portion, and means for injecting petroleum into the chamber below the level of the metal in the main portion.

2. An apparatus for treating petroleum comprising, a tubular chamber having a main portion extending substantially horizontally and adapted to contain molten metal, a plurality of risers communicating with the chamber and extending thereabove and means for injecting petroleum into the bottom of said chamber.

3. An apparatus for treating petroleum comprising, a tubular chamber having a main portion extending substantially horizontally and adapted to contain molten metal, a plurality of risers communicating with the chamber and extending thereabove, and means for delivering petroleum to the bottom of said chamber beneath one of said risers.

4. An apparatus for treating petroleum comprising, a tubular chamber having a main portion

extending substantially horizontally and adapted to contain molten metal, a plurality of risers communicating with the chamber and extending thereabove, means for delivering petroleum to said chamber at the bottom thereof, and an outlet in one of said risers to permit escape of the petroleum vapors.

5. An apparatus for treating petroleum comprising, spaced coaxially arranged tubes sealed together to provide an annular chamber having an internal passage therethrough, fusible metal in said chamber occupying the entire cross section thereof and means for injecting petroleum into the chamber.

6. An apparatus for treating petroleum comprising, a chamber extending substantially horizontally and having its entire cross section occupied with molten metal, a needle valve for injecting petroleum into the chamber, a riser extending above the horizontal chamber and substantially spaced horizontally from the needle valve, said riser adapted to contain a quantity of the molten metal above the horizontal chamber, and an outlet from said riser.

7. An apparatus for treating petroleum comprising, a chamber extending substantially horizontally and having its entire cross section occupied with molten metal, a valve controlled constricted opening for injecting petroleum into the chamber, a riser extending above the horizontal chamber and substantially spaced horizontally from the constricted opening, said riser adapted to contain a quantity of the molten metal above the horizontal chamber and an outlet from said riser.

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