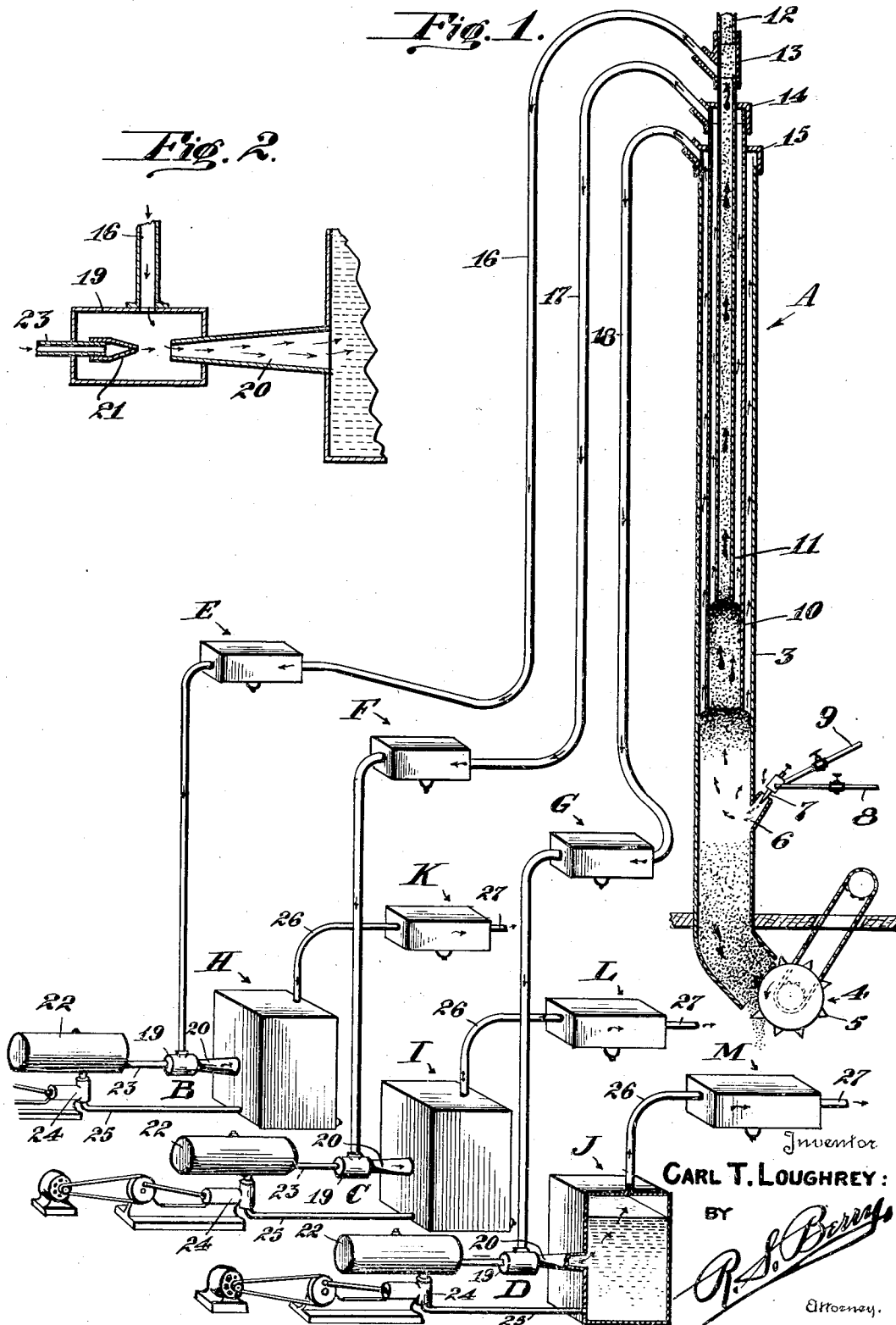


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METHOD OF DISTILLING SOLID MATERIAL CONTAINING
COMBUSTIBLE CARBONACEOUS MATERIAL
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METHOD OF DISTILLING SOLID MATERIAL CONTAINING COMBUSTIBLE CARBONACEOUS MATERIAL

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My invention relates to a method for removing and recovering the volatiles from carbonaceous materials.

The principal object of my invention is to provide a method for generating volatiles and whereby volatiles may be removed and recovered from carbonaceous material by continuous fractional distillation.

Another object is to provide a method in which fractional distillation may be effected by direct application of hot gases to the material treated.

Another object is to provide a method of the above character in which a continuous feed of the materials acted upon may be effected.

Another object is to provide a method for removing sulphur from carbonaceous material.

Another object is to provide a method whereby the materials may be efficiently treated and with such rapidity and in such quantity as to afford great capacity.

Another object is to provide a method whereby hot gases may be caused to pass through a body of broken or granular material in a positive manner by suction to effect fractional distillation of volatiles contained therein.

A further object is to provide in a distillation process a method whereby an incandescent zone may be maintained in the materials treated and hot gases caused to pass through a charge of the materials above the incandescent zone to effect fractional distillation in the charge.

With the foregoing objects in view and in contemplation of such other objects and advantages as may subsequently appear I employ an apparatus and certain steps substantially as hereinafter described and claimed and illustrated by way of example in the accompanying drawings, in which;

Figure 1 is a view in diagram showing an apparatus for carrying the method into effect;

Figure 2 is a detail in vertical section of the draft-inducing portion of the apparatus employed in drawing the products of com-

bustion and distilled volatiles from a generator.

The apparatus for carrying out my invention is here shown as comprising a generator A; a plurality of combined positive suction and ejecting devices B, C, D, for creating a partial vacuum in the generator to effect an induced draft therethrough and cause a fractional distillation of gases and vapors; initial condenser chambers E, F, and G; liquid tanks H, I, and J; and final condensers chambers K, L, and M.

The generator A embodies an outer vertical stack 3, through which materials to be treated are passed by gravity. The lower or discharge end of the stack 3, is turned to extend at an incline and is open to afford a means of discharge of residuum from the stack by gravity. A suitable feed regulator 4 is arranged at the lower end of the stack which is here shown as comprising a rotary cylinder extending across the open end of the stack to impede the progress of the materials through the stack, but which on being rotated will act to effect a continuous discharge of the materials thereby preventing excessive expansion of the materials in the stack. Teeth 5 on the cylinder act to break up the material in event it is caked and insures ejection thereof.

Opening to the side of the stack 3 is a combustion chamber 6 which extends downwardly at an angle to the vertical center of the stack and is open at its outer end to afford a means of air intake to the stack. A burner nozzle 7 projects into the outer end of the chamber 6 and is adapted to feed a hydrocarbon fuel to the stack from a pipe 8, and also to feed steam to the stack from a pipe 9. Any suitable number of these chambers and burners may be employed as occasion may require.

Extending downwardly in the outer stack 3 in spaced relation thereto is an intermediate stack 10 the lower end of which terminates above and is spaced from the chamber 6; and projecting downwardly in stack 10 in spaced relation thereto is an inner stack 11 the lower end of which terminates above the lower end of the intermediate stack 10.

The inner stack connects at its upper end with a feed pipe 12 through which the material to be treated is delivered to the stacks and which is sealed in any suitable manner not necessary to be here shown; this feed pipe where practical is extended vertically a considerable distance above the stacks and maintained full of the material.

The upper end of the inner stack 11 is fitted at its junction with the feed pipe 12 with a coupling 13, and the upper ends of the stacks 10 and 3 are closed by caps 14 and 15 respectively, which coupling and caps are connected to conduits 16, 17 and 18 leading to the suction and ejection devices B, C and D, through the condensing chambers E, F and G.

The suction and ejection devices B, C and D are complementary and each embodies a suction chamber 19, and leading from the suction chamber is a discharge passage 20 in the form of a truncated cone the small end of which opens to the suction chamber and the large end of which opens to the liquid tank at a point below the surface of a liquid in the latter. Extending into each suction chamber is a nozzle 21 which opens directly opposite the center of the passage 20 to discharge liquid into the passage across the suction chamber. Each nozzle connects with a pressure reservoir 22 through a pipe 23, and each reservoir connects with the discharge end of a suitable pump 24 the inlet of which communicates through a pipe 25 with the liquid tank in such manner that when the pump is operated a circulation of liquid will be maintained from the tank through the pressure reservoir, nozzle, suction chamber, and passage, back into the tank. The throat or passage 20 is gradually enlarged as it approaches the tank in ratio to the expansion of the ingoing stream so as to insure efficient action in inducing a partial vacuum or suction in the chamber 19 which acts to create a suction in each of the stacks to effect a positive draft and to draw off gases and volatiles as will later appear.

The tanks H, I and J connect with the final condenser chambers K, L, and M, through pipes 26, and leading from the final condensing chambers to any suitable point of discharge are pipes 27.

It will now be seen that an independent suction and condensing means is provided for each of the stacks.

In the operation of the invention, the materials to be treated are delivered by gravity to the stacks through the feed pipe 12, which materials for the purpose of the invention here set forth comprise solids in a broken, crushed or granular state and of carbonaceous character, such as shale, coal, coke, etc., but which may also consist of solids accompanied by a liquid or a semi-liquid carbonaceous substance.

The materials are delivered to the generator

in such quantity as to fill the lower portion of the outer stack 3 extending from the lower or discharge end of the stack to the lower open end of the intermediate stack, to fill the space in the lower portion of the intermediate stack below the inner stack, and to fill the inner stack preferably completely; the materials being free to gravitate from the lower or discharge end of the outer stack at a speed which may be controlled by the regulator 4 but which regulator restricts the discharge ends of the stack to retard downward movement of the mass in the stacks. It will now be seen that a continuous feed of the materials may be effected throughout the generator at a speed which may be readily controlled according to requirements. To maintain a proper charge in the stack such quantity of the materials is fed to the stack as to constantly replace the materials discharged therefrom.

On setting the suction and ejecting devices B, C, and D in operation, a positive suction is induced through the charge in the several stacks above the chamber 6 and atmosphere is drawn into the chamber 6 so that on ignition of fuel discharged from the nozzle complete combustion occurs resulting in the formation of hot products of combustion which are drawn into the charge by the positive suction and are caused to pass upward through the descending charge in each of the stacks and thereby effect distillation of volatiles in the charge. An incandescent zone is created in the charge immediately above the combustion zone through which incandescent zone the products of combustion must pass which causes a reducing action to take place on the products of combustion thereby preventing combustion from taking place in the distillation zone extending in the charge from above the incandescent reducing zone. In instances where the charge contains sufficient hydrocarbons to afford fuel for combustion the fuel from the nozzle may be dispensed with.

The suction induced in the outer stack acts directly on the portion of the charge extending between the lower end of the intermediate stack and the combustion zone, in which portion of the charge is located the incandescent zone, and serves to remove the distillates that volatilize at the high temperatures existing in this portion of the charge, and draws the majority of hot gases upward through the space between the inner and outer stacks.

The suction induced in the intermediate stack 10 acts directly to draw hot gases through the portion of the charge within this stack, which hot gases operate to distil the lighter volatiles which distil at the lower temperatures obtaining in this portion of the stack. While the hot gases in the intermediate stack are ascending, they aid, by conduction, in heating the solid column of material which is contained by the inner stack.

The suction induced in the innermost stack draws hot gases through the charge therein of lower temperatures thereby releasing volatiles that distil at the lower temperatures.

It will now be seen that I have provided a means whereby continuous fractional distillation of the volatiles in a granular or broken solid material may be accomplished.

While I have shown and described a series of three stacks with their associated suction devices and condensers it is obvious that any plurality of stacks may be employed according to the character of the material to be treated and the end sought.

The distillates liberated throughout the charge and drawn upward through the stacks together with the gases will be drawn into the primary condenser chambers E, F and G, and subjected to a cooling action resulting in condensation of a portion of the distillates in these chambers. Further condensation may take place in the liquid tanks H, I and J and final condensation is effected in the condenser chambers K, L and M, from which the gases are exhausted to a suitable point of discharge.

The method and apparatus here set forth are particularly applicable to the following uses: first, the fractional distillation of hydrocarbon; second, the production of gases; third, the making of coke and freeing it of sulphur; fourth, the production and recovery of ammonium sulphates.

In the treatment of carbonaceous materials containing sulphur, by introducing H_2O into the incandescent zone, disassociation of H_2O follows, so that the hydrogen gas combines with the sulphur and forms sulphurated hydrogen gas which is drawn out thus removing the sulphur from the residuum. This is particularly advantageous where coal is the material treated as the residuum would then be coke free from sulphur.

The generator has been shown and described for convenience as comprising a plurality of stacks which, however, taken collectively constitute a single enclosure for a column of the materials to be treated, and I therefore do not limit myself to this exact arrangement, as the essence of the present invention resides in pulling hot gases into a column of divided solid materials and drawing the gases through the column and withdrawing them therefrom by positive suctions applied to the column at spaced points, which because of the absorption of heat by the materials and the radiation and convection of heat as the gases advance through the column creates zones in the column below the points of application of the suctions of decreasing temperatures progressing upwardly.

I claim:

The herein described method of distilling solid material containing combustible carbonaceous material, which consists in pass-

ing said material substantially downwardly in a long narrow solid column through a heating zone, radially expanding said column in successive stages at definite points with respect to the length of said column, the radially expanding portions of said material below said long narrow column being progressively larger in cross-section but shorter in length than the first recited column of said material, and the first expanded portion of the said material being shorter than the second expanded portions thereof, and in simultaneously withdrawing the gases from the column proper and from the expanded portions thereof in counter current to the direction of the progress of the material being treated, there being a combustion zone in the lowermost expanded portion of the column, the hot gas from which is utilized to increase by conduction the temperature of the descending material in said solid column as said hot gas passes up therearound.

In testimony whereof I have affixed my signature.

CARL T. LOUGHREY.