Nov. 16, 1926. 1,607,240

D. J. L. DAVIS ET AL

PROCESS OF DISTILLING OIL SHALES AND THE LIKE

Filed Sept. 20, 1922 2 Sheets-Sheet 1

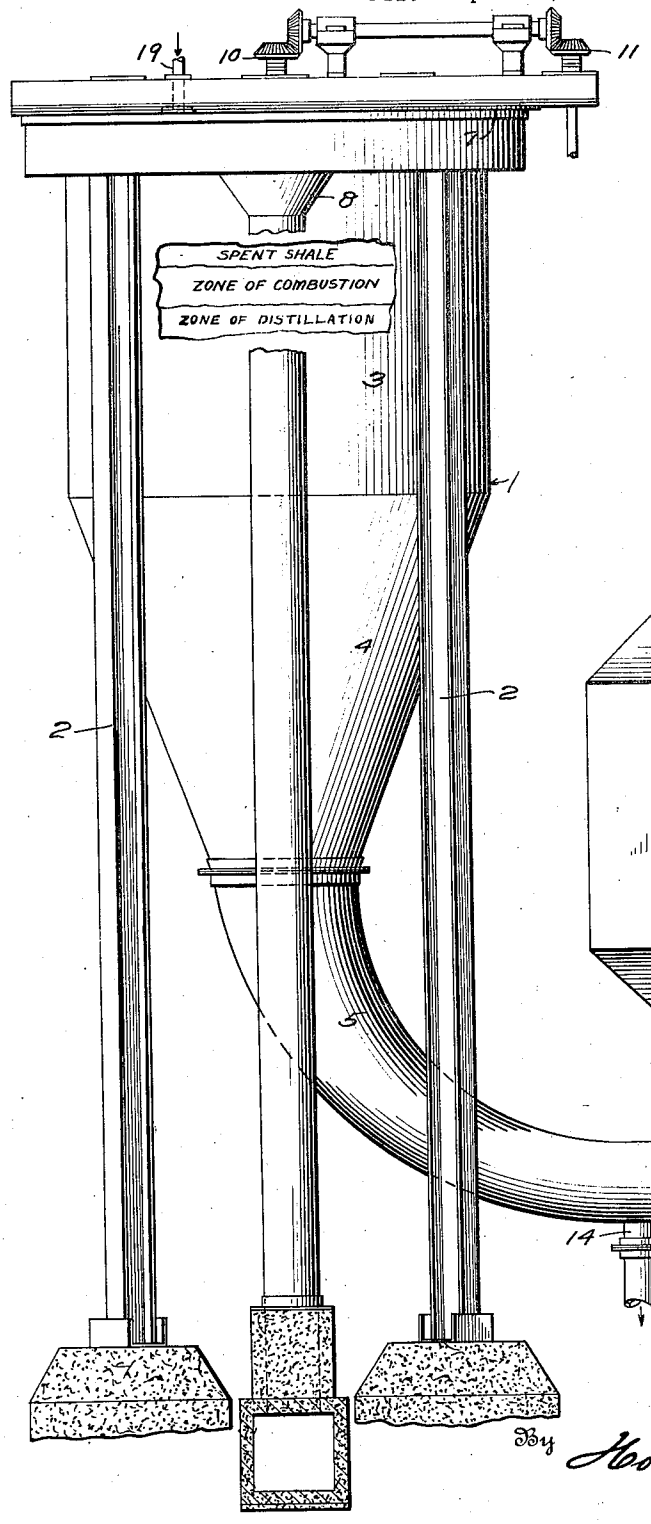

Fig. 1.

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Fig. 2.

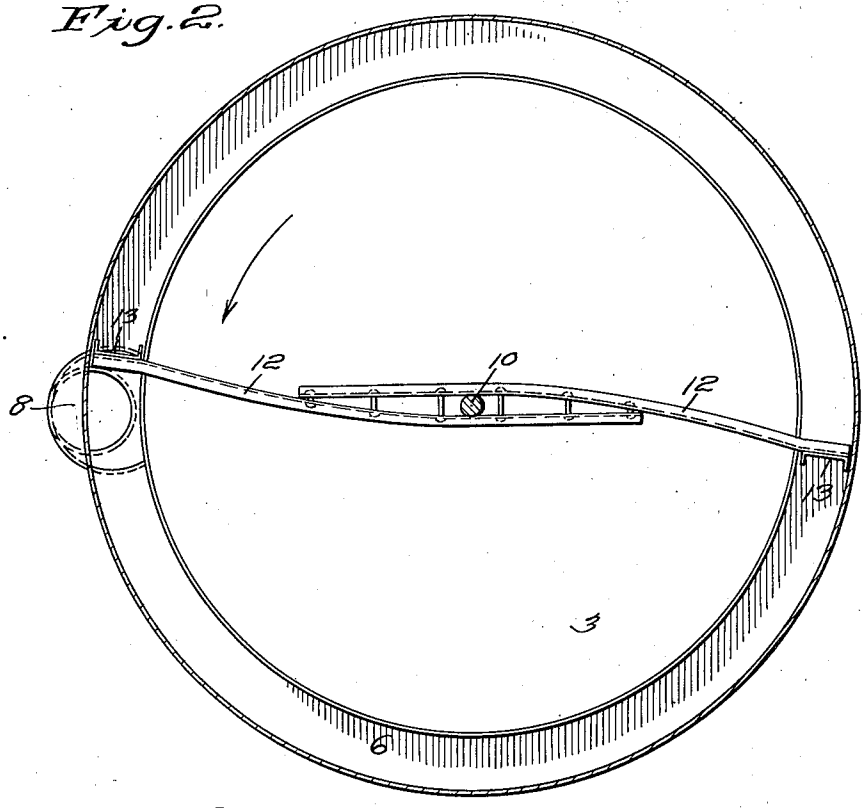
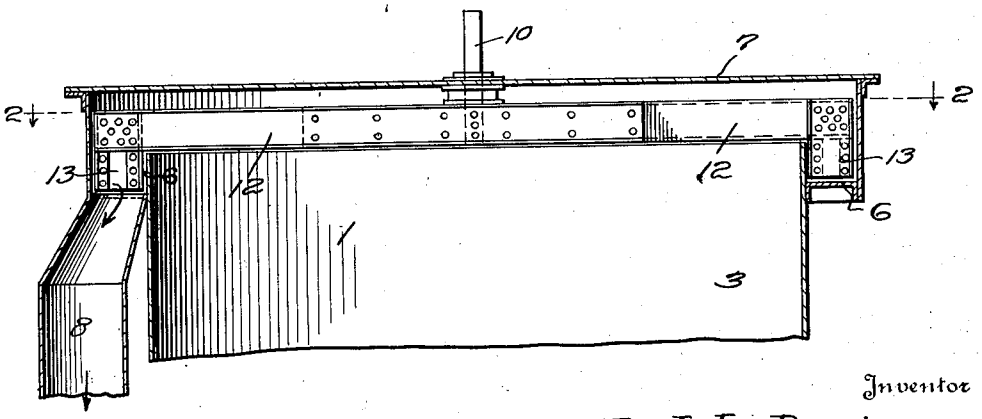


Fig. 3.



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UNITED STATES PATENT OFFICE.

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PROCESS OF DISTILLING OIL SHALES AND THE LIKE.

Application filed September 20, 1922. Serial No. 589,352.

Our invention relates to the recovery of oils and by-products from oil-shales, in which term we include all natural oil-bearing minerals, and consists, more specifically stated, in a continuous process of obtaining oils, nitrogenous compounds and other by-products, from oil-shales and other solid earthy materials, containing hydrocarbons and which yield oil when subjected to either destructive distillation or simply to heat. Heretofore this operation has usually been an intermittent one performed in a closed chamber or retort heated externally.

In the process according to our invention, in contradistinction to the previous practice, internal heat is utilized for the distillation, as by the direct combustion of a portion of the combustible substances present in the material being treated, which is constantly fed into the lower end of the chamber and upwardly through the same. It is not material to the present invention in what manner or by what means the zone of heat is initiated and maintained, (this step of the process being in itself old and disclosed, for example, in the patent to Dundas and Howes, No. 1,469,628, issued Oct. 2, 1923 to the assignee of the present application,)— since the essential features of our invention are the maintenance, in any way, of a stationary zone of heat at or near the top of a distilling chamber, and the continuous upward feed of the material being treated into and through said zone.

In the practice of our invention, we propose to proceed as follows:

A closed chamber is filled with the shale or similar material to be treated, a zone of heat is initiated on the top of this charge, air for combustion is passed downwardly through the charge, which is constantly renewed by fresh raw material being fed progressively upwardly through the chamber by means of a mechanical stoker, screw conveyor, or other suitable power apparatus. As soon as the fire is kindled on top of the charge, combustion begins to take place in the shale itself and proceeds downwardly until a zone of combustion is formed, which shortly assumes a certain thickness and a certain distance from the top of the material in the chamber, both thickness and distance being controllable at will by regulating or modifying the air and by varying the rate of feed of the material. The heat, generated in the said zone of combustion and drawn downwardly through the material by the current of air, sets up destructive distillation reactions in the upcoming material, which result in the formation of oil, leaving in the residue, from which all of the volatile hydrocarbons have been removed, a certain amount of fixed carbon. This residue, containing fixed carbon, is continuously being advanced upwardly into the zone of combustion, where it is burned, and normally supplies enough heat to the incoming material to bring about the required decomposition reactions therein, resulting in the formation of the desired oils. It is evident that, where enough free carbon does not exist to furnish the required amount of heat, a portion of the hydrocarbon content of the material itself will be burned.

In the case of materials carrying free oil, the heat, carried downwardly through the material from the zone of combustion by the gaseous products of combustion, will volatilize the contained oil. In the majority of materials, however, destructive distillation occurs and the resulting oil is a decomposition product of the complex solid hydrocarbons existing in the material. Means are provided for the removal of the residue from the top of the charge as fast as it is fed up.

In practicing our process, it is essential to be able to control the temperature, location and extent of the zone of combustion, so as to vary the intensity and quantity of the heat transmitted to the raw material being fed up towards said zone, thereby preventing the formation of objectionable clinkers and the destruction of the hydrocarbon oils initially formed. This control is obtained by varying the rate of upward feed of the material and by diminishing the percentage of oxygen in the medium of combustion, either by returning a percentage of the gaseous products of combustion, which leave the chamber, to the incoming air, or by admitting a percentage of water vapor or other inert gas with the air used to support combustion. Where the shale, or material being treated, contains a sufficient amount of nitrogenous matter, steam is the preferred medium of control as, when steam is used, an increased quantity of ammonium compounds will be formed. The degree to which the air used for combustion is modified depends entirely upon the character of material being

treated; in many cases no modification is required.

There are many advantages accruing from the use of our process which will now be evident to one skilled in the art. In addition to the low initial and operating cost of the apparatus used to practice the process, its large capacity and efficiency, the principal advantages of the process are its continuity, the utilization of direct internal combustion in the material itself and the removal of the oils, vapors and gases formed downwardly away from the zone of combustion and counter to the direction of the incoming raw material, thereby protecting the hydrocarbons from any injurious heat treatment after their initial formation, the incoming raw material cooling and condensing the oils and thereby absorbing heat therefrom, which assists in elevating the material to its decomposition temperature, as it approaches the zone of combustion.

In the accompanying two sheets of drawing, we have illustrated, by way of example, one form of apparatus by which our process can be carried out commercially, although we wish it to be distinctly understood that we are in no way limited to the precise form of apparatus shown and that the process is capable of being performed in other apparatus. For instance, the chamber may be inclined instead of vertical, as represented in the drawings, in which,

Fig. 1 is a side elevation of the apparatus, a portion of the chamber wall being broken away.

Fig. 2 is a plan sectional view of the same on line 2—2 of Fig. 3, and

Fig. 3 is a vertical central section through the upper part of the chamber.

In the example illustrated in these views, the closed chamber 1, in which the material is treated, is supported in a vertical position, by columns 2, and consists of a cylindrical section 3 at the top, a conical section 4 below said cylindrical section, and a curved tapering section 5 leading into the bottom of said conical section, the other end of said curved section having its axis horizontal and constituting the feed inlet for the raw material. The top of section 3 is surrounded by a trough 6 and the chamber is closed by a cover 7. A down-spout 8 for the spent material leads away from an opening in the bottom of said trough. On a central shaft 10, driven by the bevel gear drive 11, are carried the scraper arms 12, on the ends of which are blades 13, traveling in the trough 6. From the horizontal end of section 5, a suitably trapped outlet pipe 14 for the oils leads downward, and to the face of said end is secured the feed casing 15, containing a reciprocatory piston 16, or other suitable means for feeding the material upwardly through the chamber 1. The axis of the casing 15 is somewhat above that of the horizontal end of section 5, so that the incoming material will not interfere with the escape of the oils through the outlet pipe 14. The raw material is supplied to the casing 15, for example, from a closed bin 18. An inlet 19 is provided through the cover 7 for the air and other gases and a suction blower may be connected to the outlet 21 below the bin 18 to create a partial vacuum in the apparatus to draw the air, etc, downward through the material, or the air may be forced into the chamber and the pressure in the same be maintained above atmospheric, if desired, instead of using suction and a pressure below atmospheric. The vapors, which are not condensed by their passage through the raw material in the chamber, are preferably drawn off through said outlet 21, but may be drawn off through the pipe 20, through which the bin 18 is filled, so as to obtain additional contact with the incoming cold material before they are conducted to final condensing and scrubbing apparatus, not shown.

A portion of the uncondensable gaseous products of combustion may be returned to the inlet 19, by suitable pipe connections, not shown, so as to temper or modify the oxidizing action of the incoming air and thereby control the intensity of the combustion. Steam has the same effect and, as stated, also serves to increase the output of ammonium compounds when the shale contains considerable nitrogenous matter.

We have not attempted, and do not think it necessary, to describe here the apparatus, which forms the subject-matter of application Serial No. 589,353, filed of even date herewith, in detail, since it is desired to merely illustrate one means which may be employed to carry out the process, the operation of which will be readily understood from the above description. As before stated, the reactions which take place in the operation of our process are in no way different as far as we are aware, from those which take place in the Dundas and Howes process of Patent No. 1,469,628, aforesaid, and the regulation and modification of the air and the rate of upward feed of the material are controlled as the conditions obtaining, and results desired, at any given time, required.

Having thus described our invention, what we claim is:

1. The process of distilling oil shale, which consists in feeding a column of shale upwardly through a closed chamber, creating a zone of combustion in the shale at the top of said chamber, passing air downwardly into said zone to maintain it and to produce a zone of distillation immediately below said zone of combustion, and

continuously removing the spent shale from the top of said chamber.

2. The process of distilling oil shale, which consists in progressively feeding a column of shale upwardly through a closed chamber, creating a zone of combustion in the shale at the top of said chamber, passing air downwardly into said zone to maintain it and to produce a zone of distillation immediately beneath it, continuously removing the distilled oils and vapors from the bottom of the chamber and the spent shale from the top thereof, and modifying the oxidizing effect of the air introduced by adding products of combustion thereto.

In testimony whereof we have hereunto set our hands.

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