

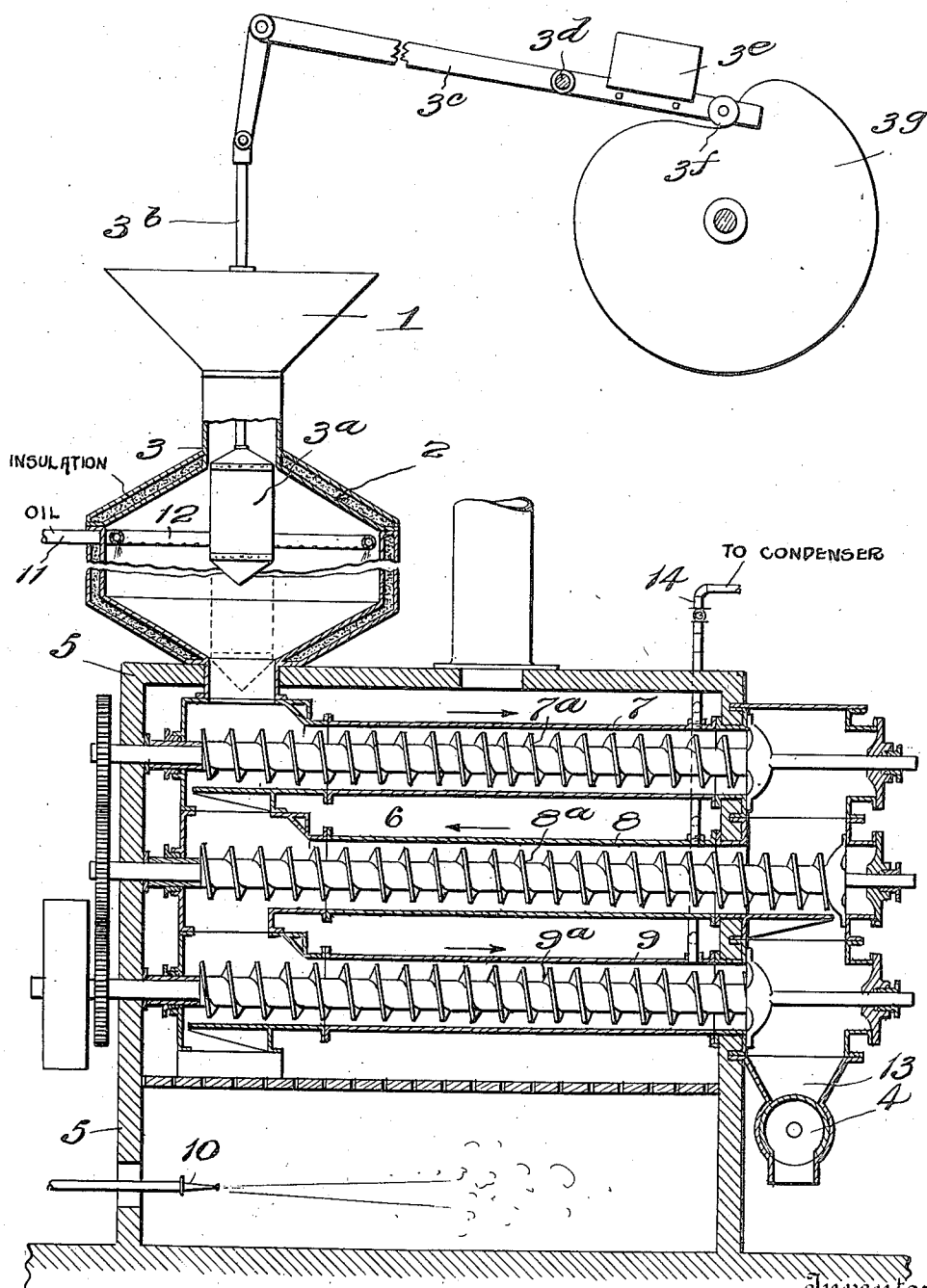
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PROCESS OF PRODUCING HYDROCARBON MATERIALS

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PROCESS OF PRODUCING HYDROCARBON MATERIALS.

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To all whom it may concern:

Be it known that I, DAVID T. DAY, a citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Processes of Producing Hydrocarbon Materials, of which the following is a specification.

This invention relates to the treatment of hydrocarbon oils to produce hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points.

It is a well recognized fact that heavy oils and tars are easily broken up by heat, and it is equally well known that processes for performing this function are often not commercially successful because no dependable scheme for removing the carbon formations has been used. One of the chief difficulties has been that carbon depositions either eventually choke up the treatment chamber or interfere with the application of heat to the material to be cracked, or in some other way interfere with the operation of the apparatus being used.

The present invention provides for the successful heat treatment of the oil and a method of continuously disposing of all deposits of coke and carbon. The invention provides for the addition of the fresh heavy hydrocarbon oil or tar to oil bearing shale and the continuous introduction into and removal from a heated retort. During this treatment the oil added and the oil vaporized from the body of the shale passes off as vapor and gas and the remaining earthy shale content is discharged along with the carbon deposited from the oil so added. The invention provides for the use of a retort having either gravity or screw conveyor means. The fresh oil or tar to be treated is added to or mixed with the oil shale before the shale reaches the retort or while it is in the retort hopper. The shale and added oil is passed through the retort by a screw conveyor. During this passage the heat on the retort walls causes the shale to give up its oil by distillation, destructive distillation, and by cracking. The added fresh oil is also partly distilled and cracked by the action of the hot vapors, which, coming from the retort traverse the shale and the added oil while still in the hopper, so that part of the added heavy oil is actually cracked to lighter products while still in the hopper. This action is undoubtedly facilitated by the catalytic

action of the shale, and the continuous process for addition of heavy oils to finely porous bodies in non-caking condition for this cracking purpose by passing the mixture through a retort and the particular way in which this is effected is a discovery for which patent is claimed. The heavy oil during distillation, destructive and otherwise from the shale gives off light oil vapors and gases and leaves coke deposits within the pores of and attached to the lumps of shales, which latter are continuously discharged as soon as the oil is sufficiently extracted.

The point of introduction of the heavy fresh oil or tar into the apparatus may be changed by injecting the fresh material into one of the hot parts of the retort so that the added material will be more quickly cracked than if the oil were added to the shale in the hopper, and with the result that any distillation of the material must necessarily take place under a cracking condition whereas if the oil were added to the shale while in the hopper distillation might take place to a mild degree without the distilled products being directly subjected to cracking temperature.

In the accompanying drawing there is illustrated one form of apparatus which may be used for conducting the process of the present invention. Referring to the details of this drawing, 1 is a shale receiving nopper to which shale may be brought by any suitable means, not shown. 2 is a main hopper below the receiving hopper 1 and constitutes a mixing chamber. Immediately below the hopper 1 and between the latter and the hopper 2 is a measuring valve 3, the chief functions of which are to provide a measured quantity of shale for the apparatus and to do this in such a manner as not to permit the upward escape of vapors or gases. The valve 3 includes a plunger 3^a having conical upper and lower ends and mounted in the mixing chamber 2. A valve rod 3^b extends upwardly through the receiving hopper 1 and is actuated by mechanism which will be described. The valve rod 3^b is attached to a lever arm 3^c which is pivoted at 3^d. A weight 3^e is adjustably mounted on the lever 3^c. The end of the lever 3^c opposite to the valve rod 3^b is provided with a roller 3^f adapted to bear on a cam wheel 3^g. When sufficient shale has entered the hopper 1 to overbalance the weight 3^e, the plunger 3^a starts downward, the cam wheel 3^g, by mech-

anism not illustrated in the present application, hastens the movement of the lever, forcing the plunger 3^a downward. During the movement of the plunger, shale is let in to the chamber 2 at the upper end of the plunger 3^a. The lower end of the plunger seals the entrance into the retort to prevent the escape of vapors and gases from the retort, as indicated in dotted lines in the drawing. As soon as the weight of the shale is removed from the top of the plunger 3^a, the weight 3^b causes it to move upward, permitting the fresh shale to cover the entrance to the retort and closing the upper end of the chamber 2 by the upper conical end of the plunger. It will be observed from the drawing that at no time in the course of rotation does the valve provide a direct passage from the hopper 2 to the atmosphere. At the bottom of the retort is a rotary valve 4 adapted to permit the discharge of spent shale but to prevent the escape of gases. Positioned beneath the hopper 2 is a furnace casing 5 providing an interior chamber 6 within which are three retort tubes 7, 8 and 9, respectively, extending horizontally and one above the other. A single tube would serve to amply describe the invention since the number, size or design of the retort tubes form no part of the present invention. The process thus provides for the application of the full force of heat to the material, sufficient to effect cracking, as soon as it enters the retort. This is because the retort tube is positioned in the furnace and the heat of the latter has free play about the retort tube to heat the same. The oil material added to the shale is thus substantially instantaneously volatilized along with whatever material may be driven off from the interior of the oil shale, and the coke formed is left on the shale and passed out of the retort tube with the shale. This heat treatment prescribed as part of the present invention is to be differentiated from the heat treatment in such processes as are directed to simple distillation and do not desire to effect cracking, and which contrasted to the present method provide relatively moderate temperature or progressive temperatures to effect fractional distillation of the crude oil which may be treated or the extraction of the oil content of shale without the cracking of such oil. In each retort tube is a screw conveyor and in the lowermost part of the furnace 5 there is a burner 10 adapted to burn gaseous or liquid fuel. Arrangement may be made for the use of solid fuel without departing from the scope of the invention. The introduction of the oil to be treated into the apparatus is provided for by a pipe 11 leading into the top of the hopper 2. By means of the perforated pipe spray 12 the heavy oil is spread over the shale and trickles down to permeate the mass. The oil shale is enriched by the addi-

tion of the oil which soaks into and saturates the shale and does not merely coat the surface. It will be recognized that it is possible to thus supplement the oil in the shale whereas it would not be advantageous to add oil to materials with which the added oil could not combine. It has been found as result of the present invention and related work that such a porous body as shale acts favorably to promote the combination of the cracked oil with the hydrogen and hydrogen-bearing gases present in the retort with constant benefit to the cracked oils.

When the oil treated shale is passed downward through the valve 3 it is passed to the right by the screw conveyor 7^a to the end of the tube 7 where it is dropped over into the tube 8 and there carried to the left by the conveyor 8^a. At the end of the tube 8 the shale is dropped down into the tube 9 and carried to the end of that tube by the conveyor 9^a where it is dumped into the space 13 to be used directly as fuel, in which case the coke adhering to the shale is consumed, or treated with steam for the production of gas. The apparatus is so timed that in the passage through the retort tubes substantially all of the oil present in or added to the shale has been driven off either as vaporized or cracked vapors, and permanent gases. The coke formation ordinarily so troublesome is carried away by the lumps of shale, which thus keep the retort clean and scour the interior thereof and the conveyor screw.

The vapors and gases driven off during passage through the retorts may be led from the apparatus through a pipe 14 and suitably condensed and trapped.

The process may be operated at a slight negative pressure or at a positive pressure up to two hundred pounds in the apparatus described. Variations in the pressures used may be made without departing from the scope of the invention. The temperatures used may vary from 500° F. to 1400° F. according to the results desired. The apparatus has been operated advantageously on California shale and added California oil at temperatures ranging from 700° F. to 1200° F. and above. Much of the material which has been added in practical operation of the process has had substantially no gasoline present but has yielded excellent amounts of this material when used in accordance with the details of the present process. Heretofore such material has been not easily used because of the choking up of the apparatus hereinbefore mentioned.

It is to be noted particularly that this process is operated by heat applied to the exterior of the retort tubes and that the process is not operated by contact with gases of combustion. Another important advantage to be found in the present process

is that the presence of a small amount of moisture, water, in the shale serves to benefit the cracking.

The process has been operated with usual results in efficiency and economy. The reason for the results obtained is attributed to the addition of the oil to be treated to the lumps of shale containing similar volatilizable material. It will be clear that there can be no coke formation within the retort tubes, and hence the heat conductance is never destroyed.

Stress has been laid in this process on the efficiency of shales which bear oil, or moisture, or both, as is usually the case. There are many other substances, however, such as naturally porous rocks—such as sandstones, or rocks which can be made porous by heat, such as limestones, which can in a commercially efficient degree be used in the place of shale. Further, such organic substances as sawdust, and similar porous bodies, have also merit for this application, and must be availed of in the proper industrial application of this process where superior porous bodies can not be obtained economically. There are many districts in the United States where there is urgent need of this efficient method of cracking heavy oils, but where oil shales, or shales merely containing moisture, do not exist in industrially economic conditions. In such cases the process must be operated with the best porous material available.

What we claim is:

1. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the oil to be treated to a mass of hydrocarbon oil bearing shale adapted to form with the non-volatile residuum of the oil a dry non-caking mixture, continuously introducing the shale with the added oil into a retort, subjecting said material while in said retort to cracking temperatures, utilizing the shale while within said retort as a scouring medium for keeping the interior of the retort free from deposits, continuously passing said material so treated from said retort, and condensing the low boiling point oils thus driven off.

2. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the hydrocarbon oil material to be treated to a mass of natural non-caking neutral material, passing the material with the added oil through a retort located in a furnace and heated thereby, subjecting said material and added oil in the

retort to a requisite degree of heat sufficient to drive off all volatilizable material and crack at least a portion of it and leave coke on the neutral material, utilizing the neutral material while within said retort as a scouring medium for keeping the retort free from deposits, and condensing the low boiling point oils driven off.

3. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the oil to be treated to a mass of hydrocarbon oil bearing shale, passing the shale with the added oil through a conveyor retort located in a furnace and heated uniformly thereby, subjecting said material while in said retort to cracking temperatures by subjecting the added oil as soon as it enters the retort to the requisite degree of heat sufficient to drive off all volatilizable material and crack a substantial portion and leave coke on the shale, utilizing the shale while within said retort as a scouring medium for keeping the interior of the retort free from deposits, continuously passing the resultant oil vapors and gas from said retort, continuously passing from the retort the shale and coke formed during the retorting, and condensing the low boiling point oils thus passed from said retort.

4. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the oil to be treated to a mass of hydrocarbon oil bearing shale, passing the shale with the added oil through a conveyor retort located in a furnace and heated uniformly thereby, subjecting said material while in said retort to a heat treatment involving a temperature of at least 700° F. initially applied with the requisite degree sufficient to drive off all volatilizable material and crack a substantial portion and leave coke on the shale, utilizing the shale while within said retort as a scouring medium for keeping the interior of the retort free from deposits, continuously passing said material so treated from said retort, and condensing the low boiling point oils driven off from the retort.

5. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the oil to be treated to natural oil bearing earthy material containing volatilizable material, passing the earthy material with the added oil through a conveyor retort located in a furnace and heated uniformly thereby, sub-

jecting said material while in said retort to a heat treatment involving a temperature of at least 700° F. initially applied with the requisite degree sufficient to drive off all volatilizable material and crack a substantial portion and leave coke on the earthy material, utilizing the earthy material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, continuously passing said material so treated from said retort, and condensing the low boiling point oils thus driven off.

6. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the oil to be treated natural oil bearing earthy material containing volatilizable material and water, passing the earthy material with the added oil through a conveyor retort located in the furnace and heated uniformly thereby, subjecting said material while in said retort to a heat treatment involving a temperature of at least 700° F. initially applied with the requisite degree sufficient to drive off all volatilizable material and crack a substantial portion and leave coke on the earthy material, utilizing the earthy material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, continuously passing said material so treated from said retort, and recovering the low boiling point oils thus driven off by condensing the same.

7. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the hydrocarbon oil to be treated to a mass of solid lumps of natural material containing moisture, continuously passing the material with the added oil through and out of a retort located in a furnace and heated uniformly thereby, subjecting the mixture while in said retort to a temperature of at least 700° F. initially applied with the requisite degree sufficient to drive off all volatilizable material and crack a substantial portion and leave coke on the natural material, utilizing the natural material in lumps while within said retort as a scouring medium for keeping the interior of the retort free from deposits, and recovering the low boiling point oils by condensing the same.

8. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the hydrocarbon oil material to be treated to a mass of nat-

ural non-caking rocky material, passing the material with the added oil through a conveyor retort located in a furnace and heated uniformly thereby, and subjecting said material and oil while in said retort to a heat treatment of at least 700° F. applied uniformly as soon as the material enters the retort to drive off all volatilizable material and crack at least a portion of it and leave the coke on the rocky material, utilizing the rocky material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, and recovering the low boiling point oils thus driven off by condensing the same.

9. The process of converting hydrocarbon oils having high boiling points to hydrocarbon oils having low boiling points and preventing carbon depositions on the interior of the treatment apparatus, which process comprises subjecting a mixture of hydrocarbon oil material and a mass of natural non-caking neutral material in a conveyor retort located in a furnace and heated uniformly thereby to a heat treatment of at least 700° F., utilizing the neutral material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, removing the neutral material with the carbon deposited thereon from the retort, and condensing the low boiling point oils thus driven off, said heat treatment being applied initially and uniformly as soon as the material enters the retort with the requisite degree of temperature to drive off all volatilizable material and crack at least a portion of it and leave the coke on the neutral material.

10. The process of producing low boiling hydrocarbon oils from high boiling hydrocarbon oils and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the high boiling oil to be converted to solid material which solid material is free from tar and any material which will become sticky under the action of the added oil and heat, passing the solid material and added oil through a screw conveyor retort, subjecting such mixture of material while in said retort to a temperature treatment sufficient to crack a substantial portion of the added oil, utilizing the solid material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, and recovering the low boiling point oils thus driven off by condensing the same.

11. The process of producing low boiling hydrocarbon oils from high boiling hydrocarbon oils and preventing carbon depositions on the interior of the treatment apparatus, which process comprises adding the high boiling oil to be converted to solid material which solid material is free from

tar and any material which will become sticky under the action of the added oil and heat, passing the solid material and added oil through a screw conveyor retort, subjecting such mixture of material while in said retort to a temperature treatment of at least 700° F. to volatilize and crack a substantial portion of the added oil, utilizing the solid material while within said retort as a scouring medium for keeping the interior of the retort free from deposits, withdrawing the aeriform material and cracked content so produced, passing the solid material out of the retort, and recovering the low boiling hydrocarbon oils by condensing the aeriform material thus driven off.

In testimony whereof, I affix my signature.
DAVID T. DAY.