May 13, 1924. 1,493,758

R. D. LAMIE.

DISTILLATION APPARATUS AND PROCESS

Filed Sept. 12, 1922 3 Sheets-Sheet 1

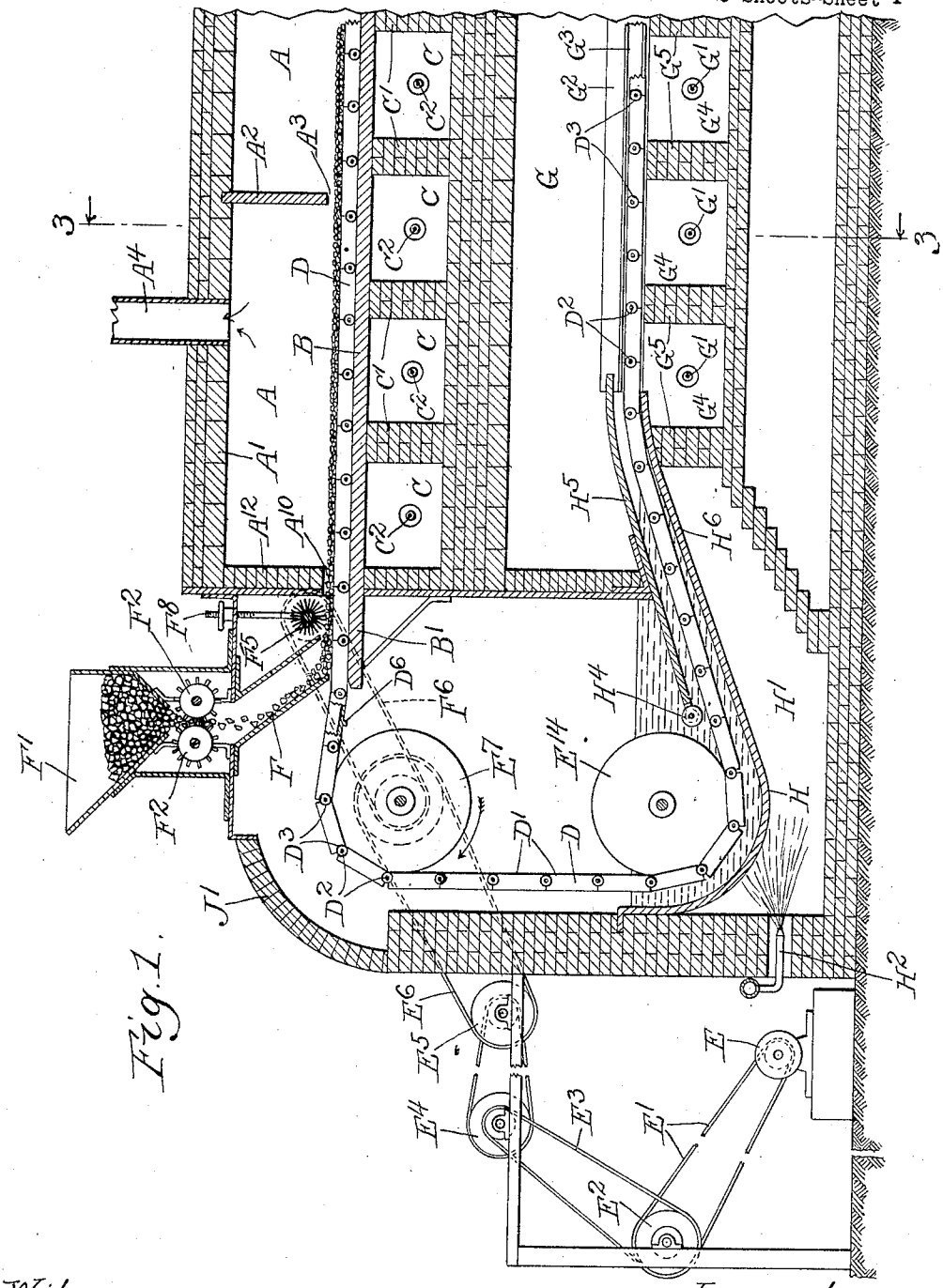


Fig. 1.

Witness.
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DISTILLATION APPARATUS AND PROCESS

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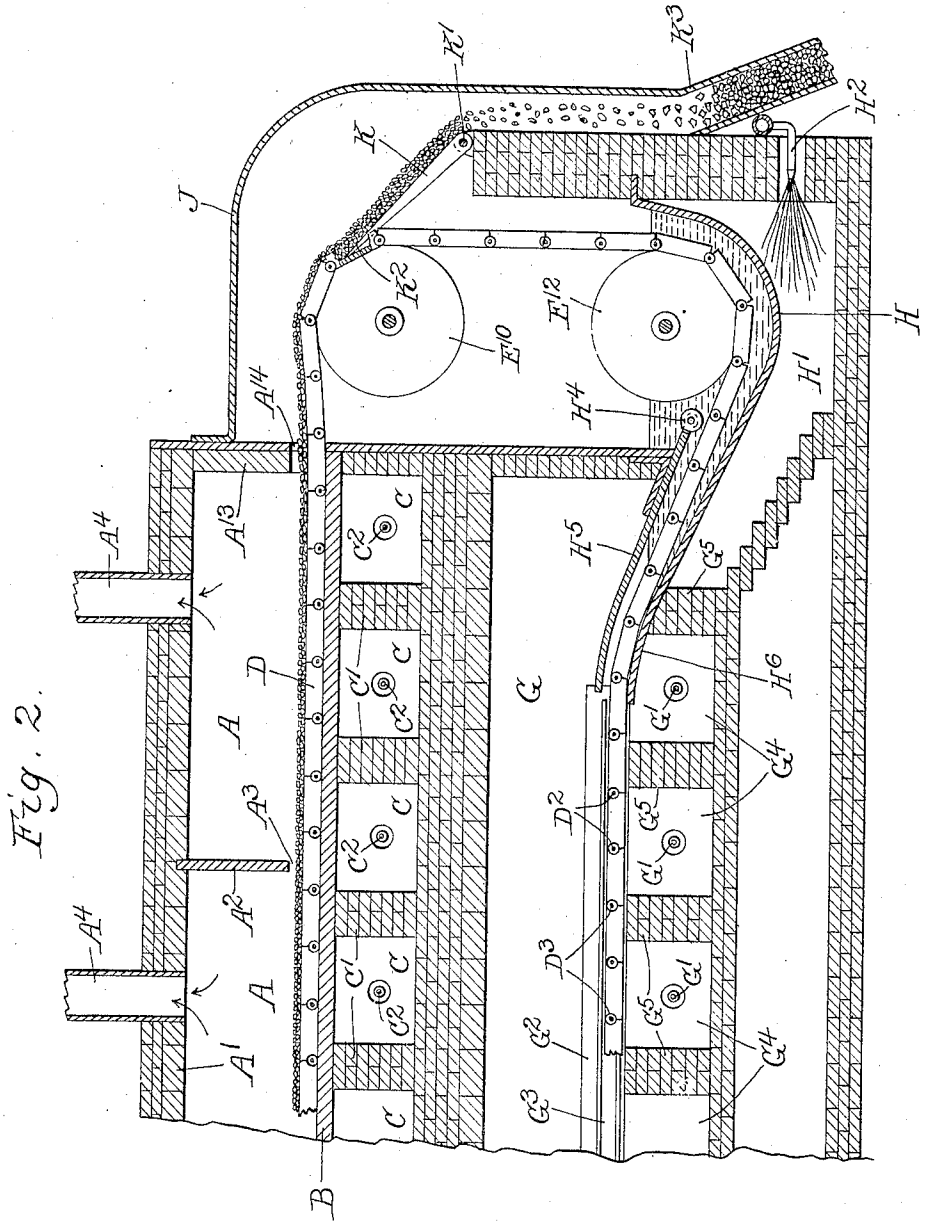


Fig. 2.

Witness.
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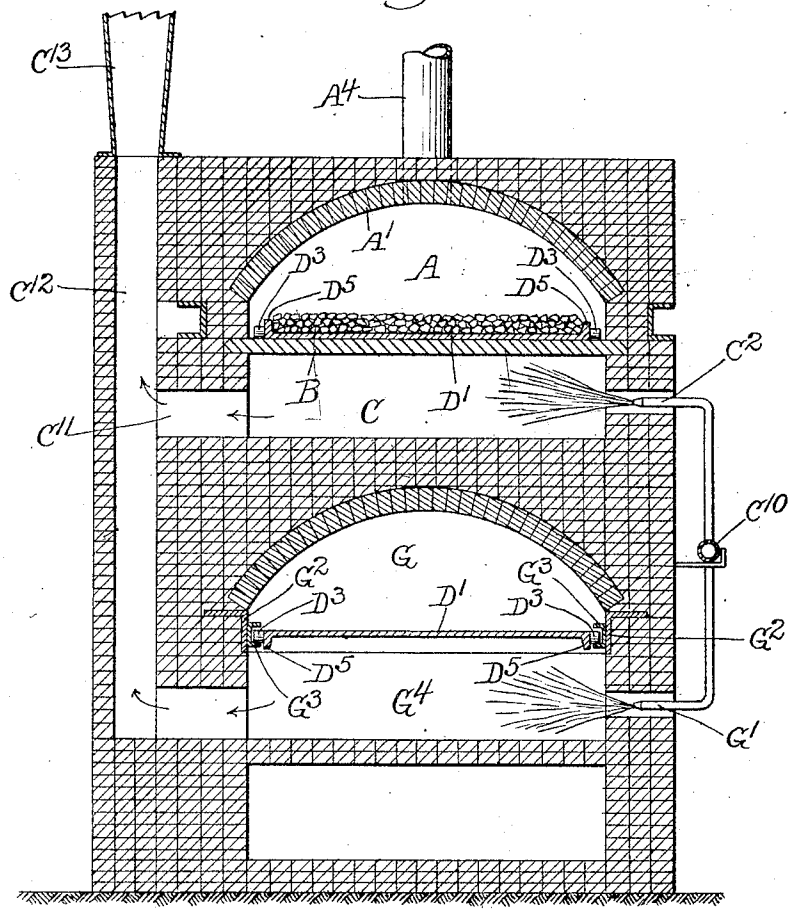
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DISTILLATION APPARATUS AND PROCESS

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Fig. 3.



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Patented May 13, 1924. 1,493,758

UNITED STATES PATENT OFFICE.

RALPH DAVID LAMIE, OF HUNTINGTON, WEST VIRGINIA.

DISTILLATION APPARATUS AND PROCESS.

Application filed September 12, 1922. Serial No. 587,721.

To all whom it may concern:

Be it known that I, RALPH DAVID LAMIE, a citizen of the United States, residing at Huntington, in the county of Cabell and State of West Virginia, have invented a certain new and useful Improvement in Distillation Apparatus and Processes, of which the following is a specification.

My invention relates to a process of and apparatus for distilling volatiles from solid or substantially solid substances and has for one purpose the coking of coal. Another object is to provide for the coking of coal with a minimum of agitation or disturbance of the coal during the coking process. Another object is the provision of a process and apparatus for coking coal wherein the distillation is accomplished at a relatively low temperature. Other objects will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the following drawings, wherein:

Figures 1 and 2 are a vertical longitudinal section of my apparatus.

Figure 3 is a section on line 3—3 of Figure 1.

Like parts are illustrated by like symbols throughout the drawings.

A is a distillation chamber which may be lined, for example, with the fire-brick lining A^1, and is preferably divided into a plurality of separate or substantially separate compartments by means of the transverse vertical partitions A^2 which extend from the top to bottom of the distillation chamber, leaving, however, openings A^3 through which the coal conveyor may pass.

A^4 are any suitable discharge vents through which the products of distillation may pass from each compartment to any suitable collection, disposal or storage means not herein shown.

The bottom of the distillation chamber A^1 is preferably formed by a horizontal floor B of carborundum or any other suitable heat resisting and ready heat transmitting material.

A section B^1 of this floor element projects outwardly beyond the end of the distillation chamber.

Underlying the floor B are a plurality of combustion chambers C separated from each other by partitions C^1 built of or lined with fire-brick. Each separate combustion chamber C is provided with one or more gas burners or other suitable combustion means C^2 which are provided with gas or any other suitable fuel through a distribution system, the details of which need not be herein described, but which is diagrammatically illustrated as a longitudinal feed pipe C^{10}, it being understood that each burner may be separately adjusted. It will be obvious that my device might be made with a single combustion chamber beneath the conveyor supporting floor, but I illustrate herein the preferred construction. From each combustion chamber C leads a lateral opening C^{11} which in turn opens on the vertical flue C^{12} which leads to any suitable outlet C^{13}.

Adapted to travel across or along the floor B is an endless conveyor D which is formed of a plurality of flat plates D^1 pivoted to each other as at D^2 and connected in any suitable manner. Outwardly projecting from each joint in the conveyor is a cylinder D^3. Each individual plate D^1 is provided with a flat bottom adapted, as shown in Figure 3, directly to contact the floor B throughout much or all of the area of the plate.

One or more of the plates may be provided with a scraper diagrammatically illustrated as D^6 adapted to scrape from a surface of the plate B any coke or other substance which might sift through to the floor of the distilling chamber.

A side ledge D^5 lines the end of each plate and forms a side wall along the entire conveyor.

The conveyor may be driven in any suitable manner but I diagrammatically illustrate a motor means E and a drive therefrom through the belt E^1, a pulley E^2, the belt E^3 the speed controlling elements E^4, E^5, the belt E^6 and finally the driving element E^7 about which the conveyor passes. I have illustrated the element E^7 as being smooth surfaced, but obviously it may be indented as a sprocket to engage any suitable elements on the conveyor chain.

Overlying the outer projection B^1 on the floor B is a coal delivery chute F which is supplied with coal which passes through the hopper F^1 and through the opposed feeding rollers F^2. Any suitable feed may be provided to maintain a constant supply of coal. In the coking operation the coal is delivered by the chute F to the conveyor

D as it passes inwardly across the shelf B^1 to the passage A^{10} in the end wall A^{12} of the distillation chamber. The coal thus supplied may be spread in a smooth layer upon the conveyor, means therefor being indicated as a brush or roller F^5 driven by a belt F^6 from the driving element E^7. F^8 is any suitable vertical adjusting means herein illustrated as a vertical screw threaded shaft and nut cooperating therewith.

When the conveyor has passed through the entire length of the combustion chamber A, it emerges through the end wall A^{13} by the aperture A^{14} and passes about the wheels or sprockets E^{10}, E^{12} between which may be positioned any suitable belt tightening means not herein described in detail.

The chain then passes through what I call a reheating chamber G which is provided with a plurality of burners G^1 which may be provided with gas or other suitable fuel through the system diagrammatically illustrated as the supply pipe C^{10}.

Mounted along the sides of the reheating chamber G is any suitable supporting element G^2 to which is secured a channel iron G^3, there being such a support and channel iron at the same height along each side of the chamber, the dimensions of the channel iron and the width of the chamber being such that the elements D^3 of the chain penetrate therein to support the chain as it travels through the reheating chamber. The reheating chamber beneath the chain is divided by the fire-brick partitions G^5 into a plurality of chambers G^4 in each of which one or more of the burners G^1 are positioned.

In order to prevent the ignition of the products of distillation from the reheating chamber, I provide a gas proof seal at each end of the chamber, it being understood that the two seals are identical. For the seal I employ molten lead, but any other suitable material might be used which is liquid but not volatile at the temperature necessary to be maintained in the course of distillation.

H is a supporting vessel beneath which is a heating chamber H^1 heated by a burner H^2 of any suitable type. The axis of the sprocket E^{12} and of the similarly placed sprocket E^{14} at the opposite end of the lower reach of the chain is beneath the level of the lead, which thus serves to lubricate the sprocket bearings. As the chain passes around the sprocket it is forced by it beneath the level of the molten lead on which it would normally tend to float. When it passes beyond the sprocket its flat under surface is contacted by the guide roller or element H^4 which is mounted at the extremity of a guide H^5 so proportioned and shaped as to cooperate with the opposite wall H^6 of the vessel H to direct the chain to the opposed channel iron supports G^2.

In order to prevent the escape and wastage of the volatiles and to permit the accurate regulation of the temperature within the system, the spaces through which the chain passes at either end outside of the distillation and reheating chambers and above the surface of the molten lead are inclosed by the air tight casings J, J^1.

K is any suitable scraping element pivoted as at K^1 upon any suitable structure or support and adapted to engage at its upper or outer edge K^2 the upper surface of each element of the conveyor chain as it passes over the sprocket E^{10}. The material thereupon passes over the scraper and is dropped down the chute K^3 for suitable conveyance or disposal. Any suitable means not herein disclosed, may be provided for maintaining the pressure within the distillation system at such a point that the outside air will neither pass down into the system through the coal crusher nor pass up into it through the coke discharging chute.

It will be understood that while I have illustrated a practical embodiment of my invention, numerous changes may be made in the number, size, shape, relation and disposition of parts without departing from the spirit of my invention and I wish that my drawings and specification be taken as in a large sense diagrammatic.

The use and operation of my invention are as follows:

I provide a coking oven in which coal may be coked at a relatively low temperature and without agitation of the coal. I provide also means for leading off the products of distillation at various points during the distillation process, thus initially segregating the various grades and types of the distillation product. I also provide a distillation system in which the temperature to which the coal is subjected is not merely controllable as a whole, but is separately controllable along the various points past which the coal travels during distillation. I also provide means for varying the time during which the coal is exposed to heat, particularly by varying the travel of the coal through the heating zone. I also provide means for maintaining the chain at a relatively high heat and for introducing it into the distillation chamber at a high heat in order to prevent the necessity of reheating the chain in the distillation chamber. In order to make this reheating of the chain possible, I segregate the distillation chamber from the reheating chamber by gas proof seals. In practice the apparatus is worked as follows:

The endless conveyor passes through the

distillation chamber or chambers, receiving coal at a point adjacent its entry into said chamber or chambers and delivering coke to the coke discharge chute after it has passed beyond the distillation chambers. The coal is supplied through a hopper and feed rollers to an inclined chute which deposits it on the conveyor as the conveyor passes over the shelf B^1 adjacent the entrance A^{10} into the distillation zone. The coal layer may be evened off on the conveyor, for example, by the brush or roller F^5 illustrated in Figure 1. When the conveyor has deposited its coke which is scraped off by the pivoted scraper K as the conveyor chain passes around the sprocket E^{10}, the chain passes through a molten lead or other suitable gas proof seal to the reheating chamber. The sprocket E^{12} forces the chain beneath the level of the molten pool and as the chain passes beyond the sprocket it is guided by the roller H^4 and the guide H^5, against which it rises in response to its relative lightness as compared to the molten metal in which it is immersed. The member H^5 guides the chain to the lateral channels or grooves in the reheating chamber along which it passes. The axis and the bearings of the sprocket E^{12} are beneath the level of the molten metal and the bearings are lubricated thereby. The chain is heated in the reheating chamber to such a temperature that when it passes out of the reheating chamber and through the second molten seal and again into the distillation chamber its temperature is but slightly below that of the distillation chamber. The reheating chamber is shown as divided into a plurality of combustion chambers over which passes the chain, but obviously a single chamber might be used or any other suitable chain heating means.

The bottom plate B of the chamber is directly heated by a plurality of combustion chambers positioned therebeneath throughout its length and is preferably of carborundum or any other suitable material which readily transmits heat. The conveyor chain itself is provided with a flat surface, the flat bottom of each of the plates of the conveyor lying directly against the top of the heated floor of the chamber. When the chain and the chamber are thoroughly heated, there is thus a direct and efficient heat transmission from the combustion chambers to the coal carried by the conveyor.

The heat of the chamber may be adjusted to suit the maximum efficiency and economy in the distillation of each type of coal dealt with and the temperature of the various subchambers into which the distillation chamber is divided may be separately regulated, as for example, by the regulation of the temperature of the individual combustion chambers. A second means of controlling the heating of the coal is provided by varying the speed of travel of the conveyor through the distillation chamber, it being thus possible readily to regulate the degree to which the volatiles are distilled out of any particular grade of coal. It is thus possible to distill off any desired percentage of the volatiles and to produce a coke having within a very small percentage any desired percentage of volatiles.

In practice it is desirable to divide the distillation chamber into two or more separate units, each with its exhaust means for the product of distillation. Thus the primary products of distillation are separated during the distillation process itself, the number of separate distillation chambers and exhaust means depending upon the required degree of initial separation.

If desired the heated coke may be passed beneath the power source in order that its heat may be practically utilized; also the distillation product itself may be used as fuel in the course of the operation. It is obvious that while I have illustrated an apparatus particularly efficient for the coking of coal, immaterial modifications only are necessary to set it to the distillation of any solid or semi-solid substance from which volatiles may be removed by heat. My invention is particularly adaptable to the distillation of oil shale.

I claim:

1. In a coking oven a distillation chamber and means for heating it, an endless conveyor passing therethrough, and a separate reheating chamber through which the endless conveyor is adapted to pass, and separate means for heating it.

2. In a coking oven a distillation chamber and means for heating it, an endless conveyor passing therethrough, and a separate reheating chamber through which the endless conveyor is adapted to pass, and separate means for heating it, and a gas tight seal between the two chambers.

3. In a coking oven a distillation chamber and means for heating it, an endless conveyor passing therethrough, and a separate reheating chamber through which the endless conveyor is adapted to pass, and separate means for heating it, and a gas tight seal between the two chambers comprising a pool of molten metal through which the endless conveyor is adapted to be passed.

4. In a coking oven a distillation chamber and means for heating it, an endless conveyor passing therethrough, and a separate reheating chamber through which the endless conveyor is adapted to pass, and separate means for heating it, a gas tight seal between the two chambers comprising a pool of molten metal through which the endless conveyor is adapted to be passed, the entrance and exit of the endless conveyor into and out of the reheating chamber being at

points beneath the surface of said molten material.

5. In a coking oven a distillation chamber and an endless conveyor passing therethrough, a combustion chamber adjacent said distillation chamber and means for separating said distillation and combustion chambers comprising a seal of liquid material, the vaporization point of which is higher than the temperature of the coking process.

6. In a coking oven a distillation chamber and means for heating it, an endless conveyor passing therethrough, a reheating chamber through which the endless conveyor passes and separate means for heating it.

7. In a coking oven comprising a distillation chamber and means for heating it, an endless conveyor adapted to pass therethrough, a reheating chamber through which said endless conveyor is adapted to pass, liquid seals between said distillation and reheating chambers comprising material having a vaporization point higher than the temperature of the coking process.

8. In a coking oven, a distillation chamber and means for heating it, an endless conveyor adapted to pass therethrough, a reheating chamber through which said endless conveyor is adapted to pass, the floor of the distillation chamber comprising a directly heated layer of heat transmitting material, the conveyor comprising a plurality of flat bottomed conveying plates adapted to rest directly thereupon.

9. In a coking oven, a distillation chamber and means for heating it, an endless conveyor adapted to pass therethrough, a reheating chamber through which said endless conveyor is adapted to pass, a liquid seal between the distillation and the reheating chambers comprising material having a vaporization point higher than the temperature of the coking process, means for carrying the endless conveyor beneath the surface of said liquid seal, supporting elements along the sides of said reheating chamber, and guiding means adapted to guide said conveyor thereto.

10. In a coking oven, a distillation chamber and means for heating it, an endless conveyor adapted to pass therethrough, a reheating chamber through which said endless conveyor is adapted to pass, a seal of molten lead between the distillation and the reheating chambers, and heating means adapted to maintain said lead in molten condition.

11. A coke oven comprising a distillation chamber and an endless conveyor adapted to pass therethrough, means for depositing the material to be distilled upon the upper surface of said endless conveyor, a plurality of transverse partitions adapted to divide the distillation chamber into a plurality of units, and means for separately drawing off the products of distillation from each of said units.

12. In a coking oven having a distillation chamber with a directly heated bottom surface, a conveyor comprising a plurality of flat bottomed plates adapted directly to contact said heated surface.

13. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, and an endless conveyor adapted to pass across said heat transmitting floor and means for delivering the material to be distilled to the upper surface of said endless conveyor.

14. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, and a conveyor adapted to travel across said floor comprising a plurality of flat bottomed plates adapted directly to contact said heated floor.

15. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, the conveyor for said apparatus comprising a plurality of flat bottomed plates adapted directly to engage the heated floor, and means for conveying said plates across said floor.

16. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, the conveyor for said apparatus comprising a plurality of flat bottomed plates adapted directly to engage the heated floor, means for conveying said plates across said floor, and means for controlling the speed of said conveyor.

17. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, an endless conveyor and means for moving it through said distillation chamber, the conveyor comprising a plurality of jointed flat bottomed plates.

18. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, the conveyor for said apparatus comprising a plurality of flat bottomed plates adapted directly to engage the heat-

ed floor, means for conveying said plates across said floor, means for controlling the speed of said conveyor, means for supplying the material to be distilled to said conveyor adjacent its point of entrance into the distillation chamber, and means, adjacent its point of exit from said chamber for removing the solid residue.

19. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a solid floor therefor, and means for heating it, a continuous flexible conveyor and means for passing it forward along and in direct contact with said floor, means for delivering the material to be distilled to said conveyor, said conveyor adapted to support said material in direct contact with its upper surface during its passage through the distillation chamber.

20. A distillation apparatus for distilling volatiles without agitation of the solids, which comprises a distillation chamber, a heated floor therefor, and means beneath said floor for heating it, a conveyor adapted to be moved across said floor and to remain in contact therewith throughout the area of said conveyor and means for delivering the material to be distilled to said conveyor adjacent its entrance into the distillation chamber, said conveyor adapted to support said material in undisturbed contact with its upper surface throughout the passage of said material through the distillation chamber.

21. A distillation apparatus for distilling volatiles without agitation of the solids, which comprises a distillation chamber, a heated floor therefor, and means beneath said floor for heating it, a conveyor adapted to be moved across said floor and to remain in contact therewith throughout the area of said conveyor and means for delivering the material to be distilled to said conveyor adjacent its entrance into the distillation chamber, said conveyor adapted to support said material in undisturbed contact throughout its passage through the distillation chamber, and means for varying the speed of the conveyor and for discharging the residue of distillation at a point beyond the exit of the conveyor from the distillation chamber.

22. In a coking oven, a distillation chamber and means for heating it comprising a horizontal floor and combustion chambers therebeneath, an endless conveyor, one strand of said conveyor adapted to pass across and in direct and constant contact with said floor, a reheating chamber near said distillation chamber and means for passing the endless conveyor therethrough, means for heating said reheating chamber and a gas proof seal between the distillation chamber and the reheating chamber at either end thereof.

23. In a coking oven, a distillation chamber and means for heating it comprising a horizontal floor and combustion chambers therebeneath, an endless conveyor, one strand of said conveyor adapted to pass across and in direct and constant contact with said floor, a reheating chamber near said distillation chamber and means for passing the endless conveyor therethrough, means for heating said reheating chamber and a gas proof seal between the distillation chamber and the reheating chamber at either end thereof, comprising a liquid bath of material non-volatile at the working temperature of the apparatus.

24. In a coking oven having a distillation chamber and a heating chamber, a conveyor adapted to pass through both said chambers, a gas proof seal therebetween through which the conveyor is adapted to pass, comprising a liquid non-volatile at the working temperature of the apparatus.

25. In a coking oven having a distillation chamber and a heating chamber, a conveyor adapted to pass through both said chambers, a gas proof seal therebetween through which the conveyor is adapted to pass, comprising a liquid non-volatile at the working temperature of the apparatus, and means for carrying the conveyor beneath the surface thereof and means for maintaining the bath in liquid condition.

26. In a coking oven, a distillation chamber and means for heating it, an endless conveyor adapted to pass therethrough, a reheating chamber through which said endless conveyor is adapted to pass, the floor of the distillation chamber comprising a directly heated layer of heat transmitting material, a plurality of separate combustion zones lying therebeneath and means for separately regulating the temperature thereof.

27. In a coking oven having a distillation chamber with a directly heated bottom surface, a conveyor comprising a plurality of flat bottomed plates adapted directly to contact said heated surface, scrapers on the bottom of said plates adapted to scrape therefrom any coke which may penetrate beneath the conveyor.

28. In a coking oven, a distillation chamber, an endless conveyor passing therethrough, a reheating chamber through which said endless conveyor passes, means for heating said distillation chamber and said reheating chamber and means for preventing the passage of volatiles therebetween.

29. In a coking oven having a distillation chamber with a directly heated bottom surface, a conveyor comprising a plurality of flat bottomed plates adapted directly to contact said heated surface, and means for varying the speed of said conveyor.

30. A distillation apparatus for solids containing volatiles which consists of a distillation chamber, a heated and heat transmitting floor therefor, and a combustion chamber lying beneath said floor and adapted to heat it, and an endless conveyor adapted to pass across said heat transmitting floor means for delivering the material to be distilled to the upper surface of said endless conveyor, and means for controlling the thickness of the layer of material so delivered.

Signed at Huntington, county of Cabell and State of West Virginia, this 5th day of September, 1922.

RALPH DAVID LAMIE.