Oct. 28, 1952 F. E. POINDEXTER ET AL 2,615,834

HORIZONTAL RETORT WITH RECIPROCATING AGITATOR

Filed Aug. 2, 1948 3 Sheets-Sheet 1

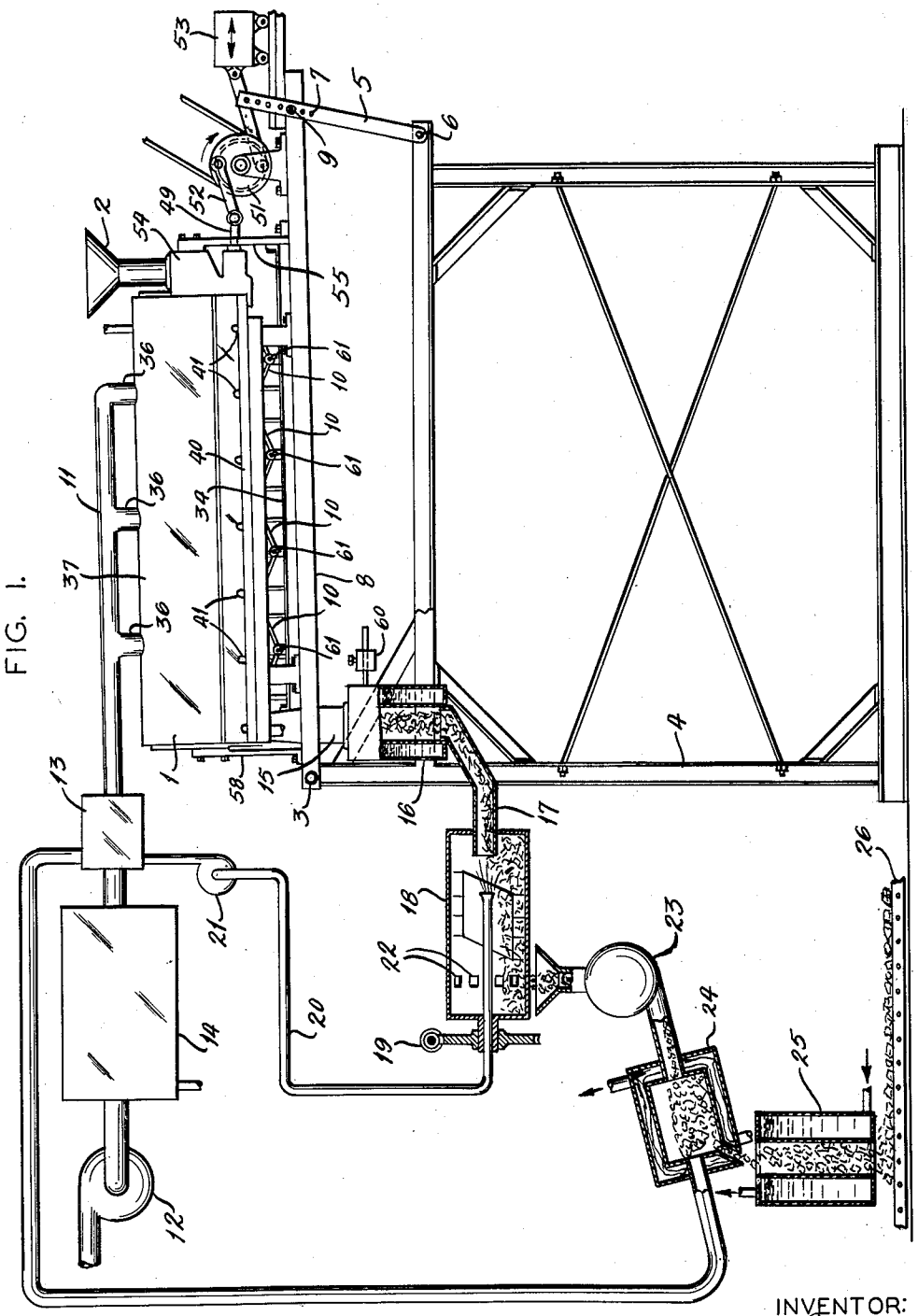


FIG. 1.

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HORIZONTAL RETORT WITH RECIPROCATING AGITATOR

Filed Aug. 2, 1948 3 Sheets-Sheet 2

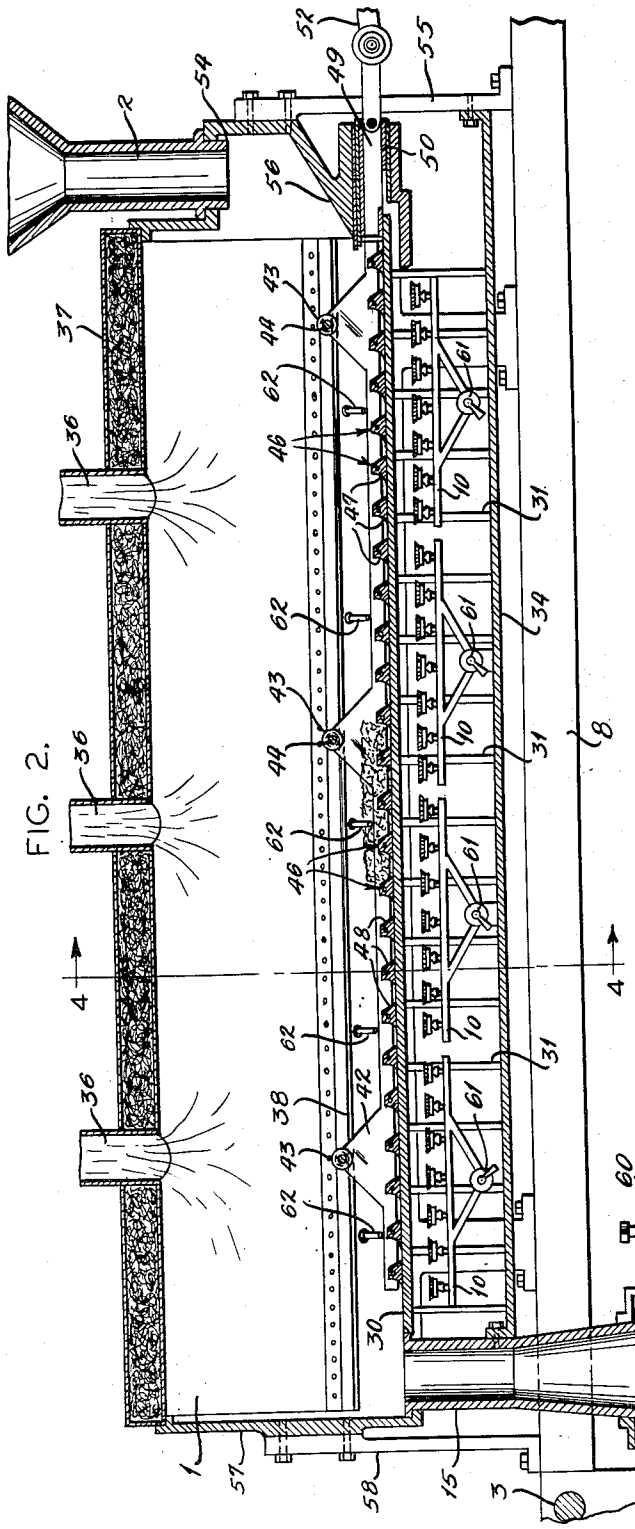


FIG. 2.

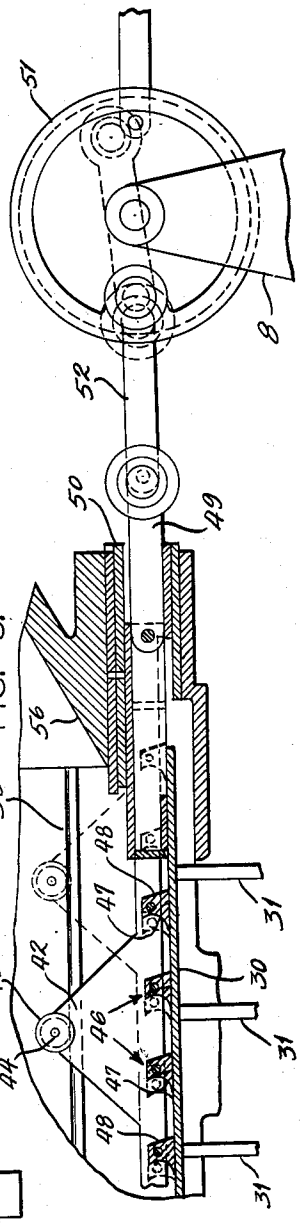


FIG. 3.

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Filed Aug. 2, 1948 3 Sheets-Sheet 3

FIG. 4.

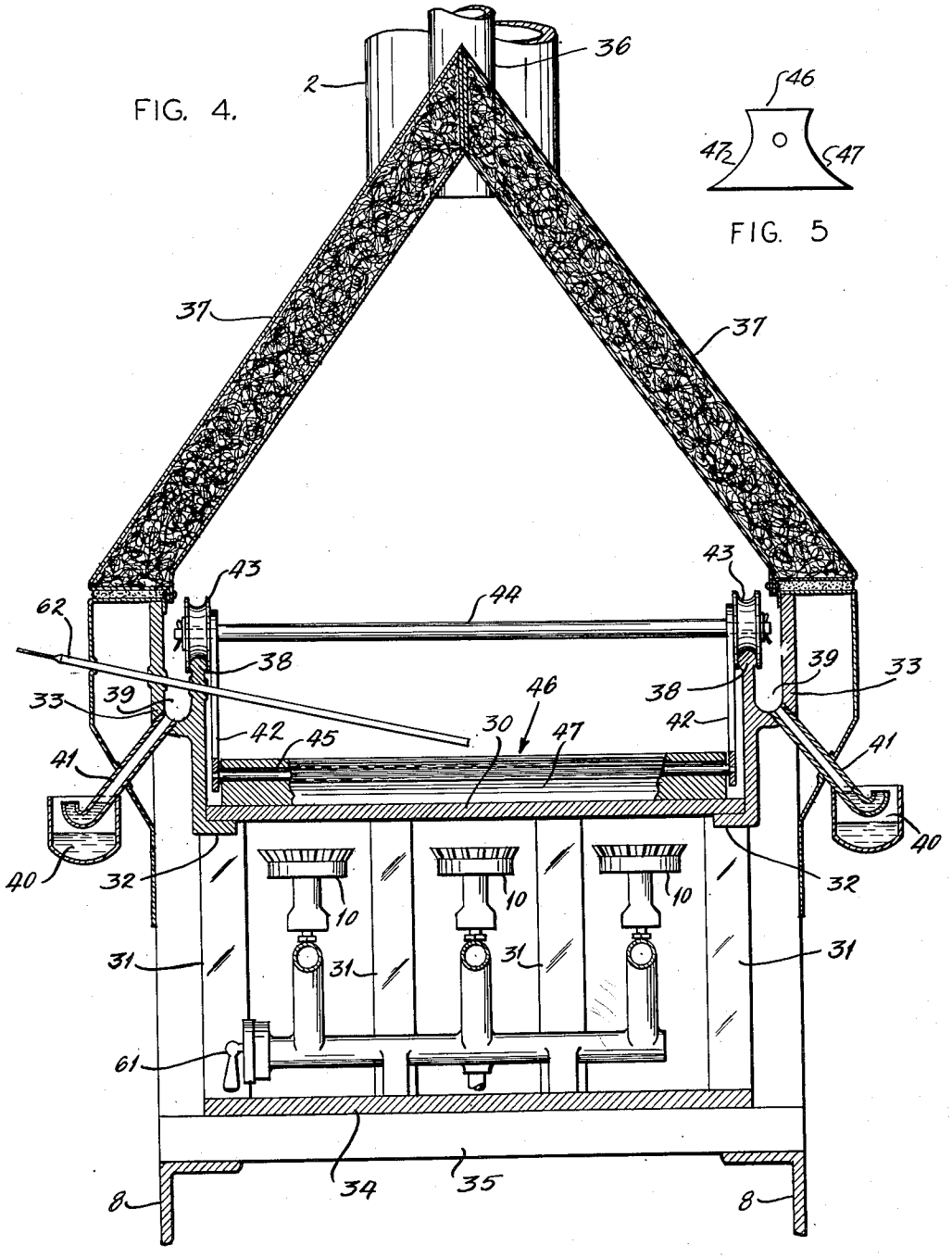


FIG. 5

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UNITED STATES PATENT OFFICE

2,615,834

HORIZONTAL RETORT WITH RECIPROCATING AGITATOR

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Application August 2, 1948, Serial No. 42,066

8 Claims. (Cl. 202—119)

1

This invention relates to the distillation or carbonization of coal or other distillable or carbonizable materials and is more particularly directed to a means and method for distillation at low temperatures.

Heretofore in many of the methods for the distillation or carbonization of coal or other distillable materials it has been customary to charge a retort with a quantity of material and then heat it to a high temperature to obtain char and all the other products of distillation. During the operation heat is supplied to the material until distillation is more or less complete, resulting in low overall heat efficiency, impurity of distillation products and the decomposition of various valuable oils and gases into less desirable products.

One of the objects of this invention is to provide a retort for distillable material containing a heated plate and which incorporates means for repeatedly lifting from and exposing the material to the plate as it is traversed thereover.

Another object of the invention is to provide a retort having a plate therein heated to different temperatures in different portions thereof over which the distillable material is passed so as to subject it to varying temperatures as it passes thereover and which includes means for rapidly and successively removing and applying unprocessed material to the heated plate.

Still another object of the invention is to provide a retort that is flexible as to temperature control zones and as to the rate of passage of the material being charred through the retort.

Another object of the invention is to provide a char briquetting manufacturing method which utilizes the char remaining after the volatile products have been distilled from the coal, which method involves the use of a mixture of tar and dust derived from the coal.

A further object of the invention is to provide a method of processing char into briquettes which utilizes some of the waste products of coal distillation and which recovers a substantial portion of the heat used in the distillation and briquetting process in heat exchangers for further use.

A still further object of the invention is to provide a mechanism for distilling coal or other distillable material at low temperatures in order to remove numerous desirable products of distillation and to recover these desirable products in purer form for various commercial uses.

In the drawings:

2

Fig. 1 is a schematic illustration of a system for charring and briquetting,

Fig. 2 is a vertical longitudinal sectional view of the distillation retort,

Fig. 3 is an enlarged sectional view of the intake end of the retort,

Fig. 4 is a vertical sectional view taken substantially along the line 4—4 of Fig. 2; and

Fig. 5 is a showing of a symmetrical style of stirring blade.

The charring of coal, peat, wood, lignite, oil shale and other carbonizable material is accomplished by introducing it in pulverized or finely divided form into a retort 1 at its intake 2, the structural details of the retort to be subsequently described. The retort 1 is pivotally supported at 3 on a suitable framework 4 and the tilting of the retort is accomplished by levers 5 (only one of which is shown), one end of which is pivoted to the framework 4 at 6 and whose opposite end is provided with a series of spaced apart perforations 7 in which are insertable suitable pins 9 (only one being shown) fixed in the frame 8 constituting a base for the retort 1. The entire assembly is easily transportable so that it can be readily moved to sources of material to be treated or processed.

The retort 1 is heated to the desired temperature by means of a plurality of gas burners 10. The gases, dust and vapors formed during distillation are drawn off through a suitable duct 11, connected to the interior of the retort 1, by a pump 12. Before reaching the pump 12, dust laden tar is collected in catcher 13. The lighter oils are condensed in condenser 14 and the remaining gases then pass to pump 12, some of the gases being used to supply burners 10 and the remainder being disposed of in any suitable manner. The oils collected in condenser 14 are separated by further processing to place them in their most desirable salable condition.

The char is discharged from the retort 1 through exit duct 15 and since it is at a temperature high enough to burn, it is first passed through heat exchanger 16 in the form of a boiler in order to recover the heat in the char and use the steam from the heat exchanger for power or other purposes.

The cooled char then passes from the heat exchanger 16, by means of duct 17, to mixer 18 whose tubular body is rotated on its longitudinal axis by gear means 19 operated by a suitable prime mover (not shown). The interior of the mixer body is provided with suitable stirring means so that dust laden tar derived from cham-

ber 13 will be mixed with the char. The chambers in mixer 18 and in catcher 13 are connected by conduit 20 in which a suitable pump 21 is interposed. The dust laden tar is introduced under pressure into the mixer 18 by pump 21. Suitable outlet ports 22 are provided in the mixer through which the mixed tar, dust and char is led into a briquetting machine 23 where briquettes are formed. The briquettes are then admitted to a caking furnace 24 to harden them preparatory to storage and shipping. The tar vapors that emerge from furnace 24 are returned to the tar catcher 13 for condensation and reuse. The briquettes are heated in caking furnace 24 above the kindling point, and, upon emerging, are cooled in heat exchanger 25, that is preferably in the form of a boiler whose steam or hot water is available for useful work. When emerging from the heat exchanger, the briquettes have been cooled below the kindling point and are carried away to storage bins on conveyors 26. The mechanism described recovers a maximum of the heat employed for coal distillation purposes and that used in caking the briquettes made from the char discharged from retort 1.

The structural details of retort 1 are disclosed in Figs. 2, 3, and 4. The frame 8 supports a hot plate 30 heated by the plurality of burners 10. This plate is preferably made from copper or a chrome steel. If copper is selected, or any other metal that softens at low temperatures, it is supported by a plurality of structural members 31 (Fig. 3), the plate being supported at its edges by brackets 32 (Fig. 4) forming part of the side walls 33 of retort 1. The frame 8 supports a bottom wall 35 upon which rests a structural member 34 that supports the structural members 31, with the gas burners 10 being supported on structural member 34. A gable roof rests upon the walls 33 into which outlet ducts 36 are fitted, the roof being made up of two insulated wall sections 37, the ducts 36 being connected to duct 11.

The side brackets 32 have tracks 38 formed thereon and the tracks, in conjunction with the side wall, form the collecting troughs 39 that extend the entire length of the retort. The tar troughs drain into collecting vessels 40 through conduits 41, the latter having traps formed therein.

The tracks 38 support carriage frames 42 on a plurality of wheels 43, each pair of the latter being connected by a rod 44. A plurality of spindles 45 are connected between each of the carriage frames and freely rotatably supported on each of the spindles is a scraper 46 that extends across the entire distance between the frames and consequently the major portion of the heated plate 30. Each scraper is provided with a curved or concave forward face 47 closely approximating that employed on one type of snow plow. The rear face 48 is a plane surface that diverges in the manner shown toward the spindle 45 so as to enable the scraper to be drawn underneath the material being processed. The rear face 48 may be curved, if so desired as shown in Fig. 5, in the same manner as face 47.

The right hand end of the scraper and carriage assembly has a rod 49 connected thereto that is slidable in a bearing 50. The rod 49 is connected by means of connecting rod 52 to a crank wheel 51 rotatably supported on the frame 8 and a track mounted counterpoise 53 is suitably connected to the crank wheel 51 at a point opposite the crank pin connection for rod 52 so as to counterbalance the action of the scraper assembly. Crank wheel 51 is driven from a suitable variable speed prime mover (not shown).

The bearing 50 is received in a housing 54 that constitutes a closure for one end of the retort 1 and in which the inlet 2 is supported. The housing 54 is supported on frame 8 by means of a bracket 55 that also supports structural member 34. The housing 54 is provided with a tapered surface 56 that deflects material to be processed into the retort and also protects rod 49.

The opposite end of the retort is equipped with a closure 57 supported by a bracket 58. The closure 57 also supports outlet duct 15 which, in turn, supports the left hand end of structural member 34. The lower end of the outlet duct is closed by a trap door 59 pivotally supported thereon and normally maintained in closed position by counterweight 60.

Each of the gas burners 10 is individually controlled by valves 61 by means of thermostatic elements 62, the two being connected together by means of suitable connections well known in the art. The thermostatic elements are adjusted so that plate 30 is supplied with a graduated heat from one end to the other, thereby providing different heat zones in the retort and holding the temperature of the material at a substantially uniform rate in each zone but not to exceed the distillation temperature.

Coal in finely divided form is admitted to retort 1 through intake 2 and falls onto the surface 56 and is deflected onto the hot plate 30. The coal or other material fills the intake 2 and prevents escape of gas and other volatile substances. The crank wheel 51 is set in operation to reciprocate the scraper carriage and coal is permitted to flow toward outlet 15, it being understood that retort 1 is tilted at a proper angle to facilitate the flow of material. The coal covers the scraper mechanism to a depth slightly greater than the height of each scraper. The plate 30 is brought up to the desired temperature in its initial zone to about 1000° F. and is held at this temperature throughout the successive zones as it progresses toward outlet 15 although lesser amounts of heat are applied to each succeeding zone of the plate. This temperature approximates that needed for most coals but the plate temperature must, in any event, be brought up to at least the minimum value necessary for any given material. The curved face 47 of scraper 46 on the forward stroke, removes hot material from the plate and lifts it upward onto and into the unprocessed material which replaces that removed. The timing or rate of operation of the scraper is such that the coal that contacts the plate remains only long enough to become heated. The tilt of the plate and the operating speed of the scraper, singly or in combination, determines the rate at which coal moves through retort 1.

Coal has a very low heat conductivity factor and, therefore, when heated will retain it. Unless stirred, considerable time elapses before all the coal in a given layer is heated. The scrapers 46 are, therefore, rapidly operated, preferably four times per second at least, so that all parts of the layer of coal will contact the plate to become heated. This act prevents excessive heating of any one part of the coal and will bring the entire layer gradually up to the desired distillation temperature. None of the distilled vapors or the residue is heated to or comes into contact with a surface that is hotter than that required to distill said vapors. Oils and gases are distilled

out, preferably during the latter part of the travel of the coal, at which time the entire mass of coal reaches the distillation temperature. Also, by agitating the coal, the layer of char on each particle is removed, therefore, exposing the interior of each particle or piece of coal directly to the plate **30**, thereby expediting the distillation process. During the return stroke of the scraper, the diverging face **48** enables the scraper to slide under the coal contacting the plate, thereby additionally agitating it. The combined action of the two scraper surfaces, therefore, negatives the poor heat conducting quality of the coal. The layer of coal is comparatively thin and being repeatedly exposed to the plate after surface char is removed, materially accelerates the carbonizing process.

Tar may condense on the inner walls of the roof member **37** and flow into troughs **39** to be collected in vessels **40**. The gaseous substances and dust, as previously stated, are drawn from retort **1** by pump **12** with dust laden tar vapor collected in catcher **13**. The other gases and oils proceed to condenser **14** where the oils are condensed, the remaining gas passing out to and through pump **12**.

By employing lower temperatures there is no appreciable decomposition of the gases and oils distilled from the coal, these products very frequently being more valuable than those produced by decomposition. The tar distilled into vessels **40** is comparatively free from carbon, rendering it more valuable and useful. The char remaining after the coal distillation operation is complete, drops into outlet **15** and is briquetted, as described above, or it may be consumed as such if so desired. The tilt of the retort, the rate of reciprocation of the scraper, and the temperatures are all controlled so that each may be adjusted for the shortest period of processing that will extract the maximum of products in their most desirable and useful form.

If we take the time,

$$t=\frac{1}{20{,}000}\text{ hr.}$$

as in the case of our small plant 1½ ft. x 10 ft. hot plate, which is the actual time between stirrings, we have

$$1140\sqrt{\frac{1}{20{,}000}}=1140\times.007=7.98\ \frac{\text{B. t. u.}}{\text{ft.}^2\ \frac{1}{20{,}000}\text{ hr.}}$$

or

$$7.98\times20{,}000=159{,}600\ \frac{\text{B. t. u.}}{\text{ft.}^2\text{ hr.}}$$

or 140 times the heat transfer when no stirring is done.

Our hot plate is 15 sq. ft. in area. So we have

$$\frac{159{,}600\times15}{1000}=2400\text{ lbs./hr.}$$

carbonized, assuming

$$1000\ \frac{\text{B. t. u.}}{\text{lb.}}$$

Below is listed four coals we have run and in each case our rate of through-put was over 1 ton/hr. This checks our calculations and assumption as to

$$1000\ \frac{\text{B. t. u.}}{\text{lb.}}$$

Run Made For—	Name of Coal	Volatility as received coal	Volatility of char	Particle size (mesh)	Date of Run
		Percent	*Percent*		
Walker W. Stevenson, 217 B'way. N. Y.	Sunneyside (Utah)----	43.6	14.9	not ground----	2/18/50
Walker W. Stevenson, 217 B'way, N. Y.	Castlegate (Utah)----	43	10.7	approx. all through 10 mesh.	2/18/50
Consolidated Coal Co., St. Louis.	Ill. No. 6----------	45	14.6	all through 28 mesh.	5/8/50
Old Ben Coal Co----------	Ill. No. 6----------	32.55 (dry)	11	.50% through 20 mesh.	2/21/51

Another use for the char is as steam boiler fuel since it can be blown directly from the outlet of the retort **1** (Fig. 1) into the fire box of a boiler.

The machine and the method in which it treats material is employable generally where distillable substances are to be removed from a mass of material, e. g., in the cement industry. The residues from those materials, after having the heat of distillation removed in a suitable heat exchanger, are then processed in accordance with customary practices in the particular industry relating thereto.

What we claim is:

1. A retort mechanism comprising a longitudinally extended housing, an elongated charring plate having high heat conducting properties mounted in said housing, means for applying heat to said plate, means for introducing pulverized material to be charred onto said plate, means for elevating one end of said housing for assisting in determining the rate of movement of the material through the retort, means for rapidly stirring and moving said material over said plate which includes a reciprocating coal agitator comprising a series of transversely extending scraping devices, each device having a substantially concave forward face and having a rearward face inclined upwardly away from the plate toward the concave face, said scraper devices moving in contact with said plate on both strokes, and extending substantially into the layer of coal for lifting and agitating the heated material in contact with said plate, off said plate and allowing unheated material to replace the heated material on both strokes of the agitating means and advance the layer on each cycle materially less than the length of the forward stroke, and means for imposing the reciprocating motion on said coal agitator.

2. A retort mechanism comprising a housing, means for pivotally supporting one end of said housing, an elongated charring plate in said housing having high heat conducting properties, means for applying heat to said plate, means for

regulating the amount of heat applied to different portions of said plate, means for introducing coal particles onto said plate, reciprocating coal agitating means for scraping and lifting coal from said plate for enabling unheated coal to contact said plate, said means including a series of transversely extending stirring and scraping blades moving in contact with said plate on both strokes, and extending substantially into the layer of coal, each blade having a concave cutting face on one side thereof and having a rearward face inclined upwardly away from the plate and toward the concave face, said faces lifting the coal from said heated plate on both strokes and advance the layer on each cycle materially less than the length of the forward stroke, and counterpoise controlled means for rapidly reciprocating said carriage means for repeatedly permitting coal particles to contact said plate.

3. A retort mechanism comprising an elongated housing, a support therefor to which one end of said housing is pivotally secured, means for controlling the elevation of the other end of said housing; an elongated charring plate having high heat conducting properties in said housing, means for heating said plate, means for introducing coal particles onto said plate, a track mounted on each side of the housing, a reciprocating coal agitator supported on said tracks, said agitator comprising a plurality of transversely extending scraper blades moving in contact with said plate on both strokes, each scraper blade extending substantially into the layer of coal and having a concave cutting face on one side thereof and a plane-cutting face on the opposite side thereof for scraping, stirring and lifting heated coal from the plate and enabling unheated coal to contact the heated plate and for advancing the layer on each cycle materially less than the length of the forward stroke, means for reciprocating said coal agitator at a high rate of speed to permit the coal particles to repeatedly contact said plate; and a counterpoise operatively connected to said last mentioned means for stabilizing the high speed action thereof.

4. A retort mechanism comprising an elongated support, an elongated housing provided with a sloping cover and having one end thereof pivoted to said support, means for changing the vertical position of the other end of said housing, an elongated charring plate in said housing, means for introducing coal particles onto one end of said plate, a trough at each side of said charring plate, a reciprocating coal agitator comprising a series of transversely extending scraper blades tiltably mounted on said agitator for movement in contact with said plate on both strokes, each blade extending substantially into the layer of coal and having a concave cutting face on one side thereof and a plane cutting face on the other side thereof for scraping, stirring and lifting heated coal from the plate during both forward and reverse strokes and to agitate the layer of coal for advancing the layer on each cycle materially less than the length of the forward stroke, and means for reciprocating the agitator at a high rate of speed over the charring plate for repeatedly subjecting the coal particles to said plate, the tar removed from the coal condensing on said sloping cover and collecting in said troughs.

5. A retort mechanism comprising a longitudinally extended housing, an elongated charring plate having high heat conducting properties mounted in said housing, means for applying heat to said plate, means for introducing pulverized material to be charred onto said plate, means for elevating one end of said housing for assisting in determining the rate of movement of the material through the retort, a reciprocating agitator means for rapidly stirring and moving said material over said plate which includes a series of transversely extending scraping devices, each device extending substantially into the layer of material and having a substantially concave face on each side thereof for lifting and agitating the heated material in contact with said plate and for advancing the layer on each cycle materially less than the length of the forward stroke in order to uniformly heat all of the material, said devices moving in contact with said plate on both strokes, means for supporting said agitator means for reciprocating motion over said plate; and means for imposing the reciprocating motion on said agitator means.

6. A retort mechanism comprising a housing, means for pivotally supporting one end of said housing, an elongated charring plate in said housing and having high heat conducting properties, means for applying heat to said plate, means for regulating the amount of heat applied to different portions of said plate, means for introducing coal particles onto said plate, reciprocating agitator means for scraping and lifting coal from said plate for enabling unheated coal to contact said plate, said means including a series of transversely extending stirring and scraping blades projecting substantially into the layer of coal and moving in contact with said plate on both strokes, each blade having a concave cutting face on each side thereof, carriage means reciprocably mounted in said housing in which said agitator means is supported; means for tilting one end of said housing for regulating the rate of movement of the coal over the plate, said agitator blades advancing the layer on each cycle materially less than the length of the forward stroke, and counterpoise controlled means for rapidly reciprocating said carriage means for repeatedly permitting coal particles to contact said plate.

7. A retort mechanism comprising a longitudinally extended housing, a charring plate in said housing, means for introducing coal onto one end of said plate, means for heating said charring plate, carriage means mounted in said housing for reciprocating movement longitudinally thereof, a plurality of transversely extending agitating scrapers supported in said carriage for movement in contact with said plate on both strokes, each scraper including symmetrical concave cutting blades on each side thereof extending substantially into the layer of coal for advancing the layer on each cycle materially less than the length of the forward stroke, means for vertically adjusting one end of said housing for tilting the charring plate, and means for rapidly reciprocating said carriage means to reciprocate said scrapers.

8. A coal carbonization retort including, a tiltable coal charring member, means for heating one side of said member, coal feed chute means to feed coal to the other side of said member for contact with the heated surface of said member, a reciprocating coal agitator comprising a series of transversely extending scrapers each having concave cutting blades on each side, said scrapers moving at a high rate of speed in contact with the surface of said coal charring member on both strokes, and extending substantially into the layer of coal, and arranged to lift the coal from

the heated surface of said member on both strokes and to agitate the layer with advancement of the layer on each cycle materially less than the length of the forward stroke.

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