June 3, 1969 V. D. ALLRED 3,448,012

ROTARY CONCENTRIC PARTITION IN A COKE OVEN HEARTH

Filed Feb. 1, 1967

Sheet 1 of 2

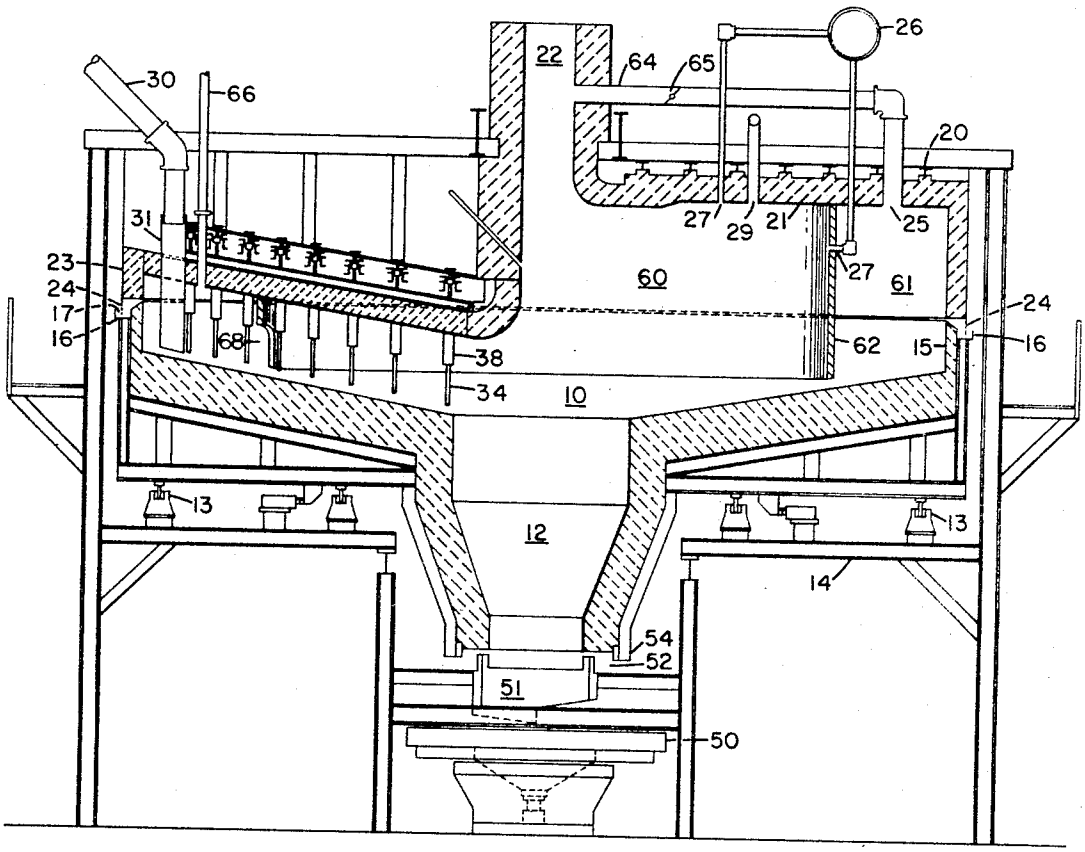

FIG. 1

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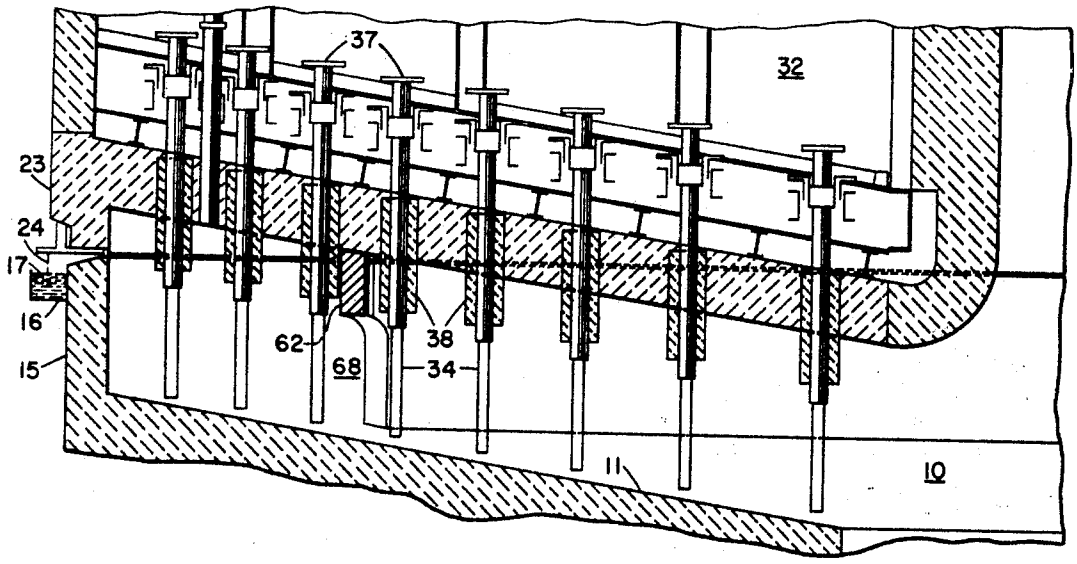

FIG. 2

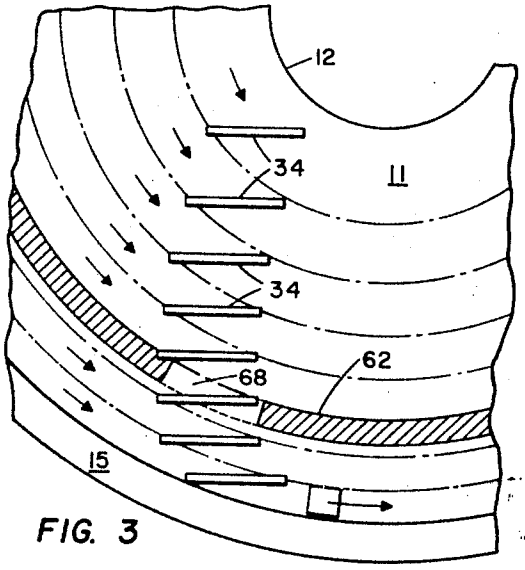

FIG. 3

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United States Patent Office 3,448,012
Patented June 3, 1969

3,448,012

ROTARY CONCENTRIC PARTITION IN A COKE OVEN HEARTH

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Filed Feb. 1, 1967, Ser. No. 613,145
Int. Cl. C10b 49/06, 37/00, 47/18
U.S. Cl. 201—27 9 Claims

ABSTRACT OF THE DISCLOSURE

A coke oven chamber is comprised of a conical hearth with an outlet at the center and lowermost portion. An overlying rotary cap has spaced rabbles depending therefrom disposed to move material on the hearth progressively inwardly towards the material outlet. The cap is further provided with a cylindrical partition depending from it and coaxial with the outlet. The partition extends into a bed of material on the hearth.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to methods and apparatus for the treatment of materials under profiled temperature conditions which materials yield oxidizable volatile matter under the action of heat. Especially preferred applications of the present invention include the devolatilizing (that is, calcining, coking, degasing or otherwise devolatilizing, solid materials, e.g. coal (coking or noncoking) coke, pitch, tar, asphalt, lignite, gilsonite, petroleum coke or other residua from the refining of petroleum either in their natural state or mixed or unmixed in the form of briquettes or other cohesive shapes.

Description of the prior art

The present invention devolatilizes the material being treated by the direct application of heat to the material preferably or largely through radiation from the roof and side walls of the devolatilizing chamber, such heat being supplied by oxidation within the chamber of the oxidizable volatile matter being continuously driven off by the material being treated, and in addition the present invention provides a plurality of zones substantially gas type one from the other within said heating chamber so that various temperatures can be maintained within a single furnace while the material is free to move from one zone to another under the action of plow-like rabbles which move relative to the hearth of the furnace. The simplicity of the process and apparatus of the present invention is in marked contrast to the closed pots, containers or cars moved through heating chambers which have been used heretofore.

SUMMARY OF THE INVENTION

The present invention is to be limited only by the claims appended hereto and the abstracts, examples and summaries included within the present disclosure are to be taken as being merely illustrative of the invention. However, the invention offers apparatus and means for providing a variety of temperatures within a furnace which is at least partially heated by the oxidation of volatile matter which is removed from the material being treated through the action of heat. This profiled temperature is highly useful where it is important that the materials not be thermally shocked. In such cases a relatively cool zone can be maintained near the inlet to the furnace and materials can gradually pass under the partition means separating this zone from the next inner zone which can be maintained at a higher temperature and additional successive inner zones maintained at successively higher temperatures can be provided until the treatment of the material is complete and the material drops through an outlet located at or near the center of the hearth.

The materials being treated are preferably moved through the furnaces of the present invention by means of rabbles which operate like plows and which move relative to a hearth, preferably imperforate, so as to distribute the material on the hearth in a series of preferably concentric furrows which are turned over wholly or partially by each pass of the rabbles through the bed. The zones of different temperatures can be separated by providing partition means, preferably curtain walls, which are attached in substantially gas impervious, mechanically fixed relationship to the top or outer walls of the furnace chamber and which extend downward to a point near the top of the bed so as to permit movement of the bed under the partition means while preventing major flow of gases from one zone to another. The temperatures within the zones may be controlled either by the autogenous process of reducing volatiles and oxidizing them within each of the zones at a rate sufficient to give the temperature desired in each particular zone. Alternatively, burners or cooling means such as cold air blowers can be provided to control the temperatures within the various zones. Particularly preferred are processes where, as the zones become progressively hotter, more volatiles are removed from the material in the inner zones so as to maintain a higher temperature in those zones and exhaust gases from the inner zones are conducted through at least a portion of the outer zones where they may be mixed with air or otherwise controlled to give lower temperatures in such outer zones. The flow of gases to the outer zones may be either cocurrent or concurrent with the movement of the material on the bed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a vertical section through a furnace according to the present invention;

FIGURE 2 is an enlarged detailed view showing the rabbles, and the partition means of FIGURE 1;

FIGURE 3 is a planned detailed view of a portion of the hearth showing the rabbles and curtain walls.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGURE 1 shows a furnace having a rotary hearth **10** with an inner hearth surface **11** sloping from the outer periphery downwardly to a central axially extending soaking pit **12** integral with and depending from the hearth **10**. The rotary hearth **10** is supported on spaced rollers **13** mounted on a furnace frame **14**. The hearth is rotated by a motor and a rack and pinion drive in a conventional manner for rotary hearth furnaces. A curb **15** extends vertically above the hearth's surface **11** at its outer periphery and carries a waterseal **16** filled with water **17**. Sand, fluid coke, or similar pulverized material can be used instead of water, if preferred.

The furnace frame **14** carries roof beams **20** which support a cast refractory roof **21** having a central flue **22**. The roof **21** has a depending wall **23** carrying flange **24** which extends into the water **17** carried in water seal **16**. The roof **21** is provided with wickets or nozzles **27** which receive air from duct **26** mounted on the furnace frame **14**. The ports **27** direct gases gently downward toward the hearth. Top **21** and side walls **23** of the roof are provided with ports **27** receiving air from duct **26**. The ports **27** direct air across the hearth in a radial direction. In a particular preferred embodiment shown in FIGURE 1 all of the ports **27** direct air into the inner chamber **60** which is separated from the outer chamber **61** by a refractory curtain wall **62** which extends downward from the room **21** to a point about six inches above the interior hearth surface

11. This curtain wall 62 extends concentrically all around the hearth so as to substantially completely separate the inner chamber 60 from the outer chamber 61 excepting only the notch 68 between the lower edge of the curtain wall and the inner hearth surface 11. (In other embodiments a wall which only separates a segment of the furnace could be used.)

Burners 29 (not shown) are provided in the roof of the inner chamber to bring the furnace to operating temperature and to provide additional heat for those reactions which are not completely autogenetic. A feed chute 30 passes through the roof 21 adjacent the side wall 23 and is provided with a vertically adjustable delivery end 31 extending to a point adjustably selected to deliver a selected thickness of feed onto hearth surface 11. A radially extending U-shaped rabble pit 32 (shown in FIGURE 2) is formed in the roof and extends radially from the flue 22 to the roof wall 23. The bottom of this pit 32 is provided with slots adapted to slidably receive rabbles 34. Rabbles 34 may be solid or of hollow platelike structure with inner vertical baffles depending upon the temperature involved. For the higher temperatures, of course, the latter is preferred. Each baffle is provided with inlet and outlet coolant conduits which also act as supports for the rabbles. Coolant such as water or air is delivered to the inlet and into rabble 34 on one side of the baffle and then under the baffle to the opposite side of the rabble and out through the outlet pipe 37. Refractory seals 38 are provided on conduits 36 and 37 to fit within slot 33. The conduits 36 and 37 are held between two angular rabble holders which are held together by bolts. The rabble holders 39 and 40 are fastened between adjustable carrier angle beams and by bolts. Vertical adjustment screws are provided at each end of each adjustable carrier beam. These screws bear on fixed rabble beams which extend across the rabble pit 32 as shown in FIGURE 3 and serve to vary the currents between the lower end of the rabbles 34 and the interior surface of the hearth 11.

A rotary discharge table 50 is provided beneath the soaking pit 12 to receive the output of the furnace. A fixed discharge spout of plow 51 is mounted in frame 14 between the soaking pit 12 and discharge table 50 with spout 51 is provided with a peripheral trough 52 carrying sand 53 into which a depending flange 54 on the soaking pit extends to form a seal.

The operation of the furnace described above is as follows. The burners 29 are fired to bring the furnace up to the desired temperature which depends upon the nature of the material being devolatilized or calcined. Material to be treated is fed through feed chute 30 and is continuously spread to the desired thickness and width along the outer periphery of hearth surface 11. As the hearth rotates the material encounters the rabbles 34. Each set of rabbles deflects materials striking it into the next adjacent concentric furrow ring so that the flow of material from the periphery of the hearth surface 11 to the soaking pit 12 is generally in spiral concentric rings, each of greater width so that as the rings become smaller the area becomes greater providing a uniform depth. Material moves under the curtain wall 62 through a notch 68 in its lower edge so positioned as to receive material from one of the rabbles 34. These concentric spiral rings are diagrammatically illustrated in FIGURE 3, together with the relative position of each rabble with respect to such rings. The vertical position of the rabbles determines the residual amount of material which is to be left on each ring as the hearth rotates. The rabbles tend to cause mixing and inversion of the bed several times as the material moves downwardly from the hearth periphery to the soaking pit. This permits more uniform heating and provides a more uniform product and is an important attribute of the present invention.

Exhaust gases exit through flue 22 or may be partially diverted through conduit 64 past adjustable damper 65 and downward into the outer chamber 61. The exhaust gases then flow substantially circumferentially through outer chamber 61 until they reach a second flue 66 from which they exit. Gases exiting from flue 66 may be conveyed back to mix with gases from flue 22 or separate stacks or other venting points may be provided for each of the flues.

To even further enhance this mixing the hearth may be arranged in a series of steps like a circular amphitheater so that the rabbles push material off one step and cause it to cascade down to the next step where the next rabble then pushes it to a succeeding lower step, etc. This method is especially advantageous where a large amount of fines are involved and where such fines must frequently be brought to the upper surface of the bed in order to achieve product uniformity.

It will be understood that the invention is susceptible to a wide variety of modifications and variations many of which will be obvious to those skilled in the art. For example, it is possible to have various configurations of rabbles other than the flat quadrangular rabbles illustrated e.g. mold boards or conventional plow designs may be utilized where desired. Another important variation is that the damper 65 in conduit 64 may be completely closed on conduit 64 completely eliminated so that no gases flow from the inner chamber to the outer chamber. Each chamber will then be under a temperature which is determined by the amount of volatile matter released and consumed and this temperature may be varied by varying the rate of heat of oxygen or may be varied by the operation of burners in either or both of the inner and outer chambers 60 and 61. It should be also understood that the number of chambers need not be confined to two and that the invention may be practiced with a number of concentric curtain walls dividing the furnace interior into a number of individual zones, each being operated at a different temperature.

Thermostatic and other automatic controls may of course, be utilized for the control of hearth rotation, temperature within the individual zones, cross flow of gases through conduits from one zone to another, etc. Likewise, the applications of the furnaces of the present invention are many and varied. However, it should be noted that among the most preferred applications of the invention are its use in first drying and then calcining raw coke, especially petroleum coke which is frequently wet with 10% or more by weight of water during its process of manufacture. The drying may be accomplished in the outer zone at temperatures which are not sufficient to devolatilize such petroleum coke to any substantial degree, e.g. temperatures below about 500° F. At higher temperatures, e.g. above about 2000 degrees F. maintained within the inner chamber, the coke may be calcined by the methods of the present invention with all of its attendant thorough mixing and uniform quality of product. Exhaust gases from one zone can be used to heat other gases, e.g. air in a suitable gas-to-gas heat exchange and such other gases may be conducted into a second zone. These, and all other modifications which are obvious to those skilled in the art upon a reading of the present application, are to be taken as being included within the claims appended hereto.

What is claimed is:

1. An oven comprising a heated chamber, a hearth located in the chamber, a material outlet at the center of the hearth, means for delivering material to the hearth adjacent the outer periphery thereof to form a bed of material on the hearth, spaced rabbles disposed above the hearth and disposed to move material on the hearth progressively inwardly toward the material outlet upon relative movement between the hearth and the rabbles, at least one substantially cylindrical partition means coaxial with the hearth center dividing said chamber into at least one inner zone and at least one outer zone, said partition means having upper and lower edges, the upper edge of said partition means being connected to the wall enclosing said chamber so as to form a seal substantially

impervious to gases and mechanically fixed to said chamber wall, said partition means extending downwardly toward said hearth and terminating in a lower edge substantially parallel to said bed and disposed close to the top of said bed, and wherein an exhaust exit for gases is provided from at least one inner zone and conduit means connects said exhaust means to an inlet in at least one outer zone so that exhaust gases from said inner zone or gases heated by said exhaust gases flow through at least a portion of said outer zone, whereby material on the hearth moves progressively inwardly passing substantially under said partition means and whereby only minor flow of gases between said inner and said outer chamber occurs between the top of said bed and the lower edge of said partition means.

2. The oven of claim **1** in which the hearth is substantially horizontal and imperforate.

3. The oven of claim **1** in which the hearth is substantially horizontal and imperforate.

4. A process for devolatilizing material which yields oxidizable volatile matter under heat continuously comprising the steps of

(a) continuously delivering the material to be treated onto a hearth in an outer zone of a heated oven chamber adjacent the outer periphery thereof to form a bed thereon,

(b) relatively moving the hearth and the material thereon with respect to a plurality of spaced rabbles disposed above the hearth,

(c) progressively advancing the material toward a material outlet at the center of the hearth by disposing said rabbles such that they extend into the bed at an angle of attack that moves the bed progressively inwardly toward said material outlet,

(d) turning the bed over and over during its progressive movement toward the material outlet,

(e) moving the bed under a partition means which separates said outer zone from an inner zone also located within said heated oven chamber, discharging the treated material into a material outlet located within said inner zone substantially at the center of the hearth,

(f) burning at least a portion of said volatiles within said inner zone.

5. The process of claim **4** wherein gases evolve from said inner chamber, are conducted through at least a portion of said outer chamber, and wherein said outer chamber is maintained at a temperature substantially lower than the temperature within said inner chamber.

6. The process of claim **5** wherein the temperature in said outer chamber is sufficiently low so as not to heat said bed to a temperature above about 500 degrees F. and wherein the temperature within said inner chamber is above about 2,000 degrees F.

7. The process of claim **6** wherein the hearth rotates substantially about its center point and wherein gases from said inner zone are conveyed through at least a portion of said outer zone in a direction concurrent to the rotation of said hearth.

8. The process of claim **6** wherein said hearth rotates substantially about its center point and wherein gases from said inner zone are conveyed through at least a portion of said outer zone in a direction cocurrent to the rotation of said hearth.

9. The oven of claim **1** comprising a plurality of partition means dividing said heated chamber into at least three zones.

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U.S. Cl. X.R.

201—33; 202—103; 263—26

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,448,012 June 3, 1969

Victor D. Allred

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 18: Delete "1" and substitute therefor -- 9 --.

Signed and sealed this 4th day of November 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents