CONTINUOUS FURNACE FOR CONVERTING MATERIAL

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The present invention relates to a continuous furnace for converting material, such, for example, as products of chemical or thermo-chemical processes provided with a revolving hearth and stationary radial rabbled arms and in which individual rabbled arms may be withdrawn from the furnace without interference with the operation thereof.

This invention is in the nature of an improvement on my invention disclosed and claimed in issued Patent 2,471,862 granted to me May 31, 1949. The said patented invention shows in part a rotary hearth furnace of which the present invention includes improvements particularly advantageous to continuous operation and high temperature work.

An important object of the invention is to provide a novel and advantageous form of furnace of the general character specified.

Another object of the invention is to provide a rotatable-hearth furnace of the general character specified wherein air is supplied to the outer end of each rabbled arm at one side of a partition, passes to the tip of the rabbled arm and around the end of said partition and then passes at the other side of the partition to the outside of the furnace.

Still another object of the invention is to provide a furnace of the general character specified wherein the outer end of each rabbled arm at the wall of the furnace is so mounted that the rabbled arm can be released, picked up by suitable means and withdrawn from the furnace to make way for a replacement rabbled arm.

Yet another object of the invention is to provide a furnace of the general character specified wherein the outer end of each rabbled arm at the wall of the furnace is so mounted that the rabbled arm can be released, picked up by suitable means and withdrawn from the furnace to make way for a replacement rabbled arm.

A further object of the invention is to provide a furnace of the general character specified having a central opening in its roof for upward flow of gases, stationary rabbled arms, a revolving hearth with a central projection beneath the opening in the roof and limiting the length of the rabbled arms, a material inlet at one side of the roof opening and a material outlet at the periphery of the hearth.

A still further object of the invention is to provide a furnace of the general character described with a central stationary pier surrounded by an annular rotary hearth, the material being fed to the annular hearth near its inner edge and rabbled, countercurrently to the gas flow, outwards to the outer edge of the hearth where it is discharged.

In carrying out the invention, use is made of a furnace having a low roof over a rotary hearth so as to assure contact (in the bottom) with material on the hearth. According to one embodiment of the invention the rotary hearth has a central discharge opening and the material to be treated is fed to the rotary hearth near its periphery. As the hearth rotates the material is fed towards the central opening by means of inclined rabbled blades on stationary rabbled arms supported at their outer ends at the peripheral wall of the furnace. Each rabbled arm is hollow and is divided into two parts by a longitudinal partition so that air supplied from a supply duct at the outside of the furnace to the rabbled arm at one side of the partition will pass to the inner tip of the partition and back at the other side thereof to a discharge duct at the outside of the furnace. The connections between each rabbled arm and supply and discharge ducts at the outside of the furnace are such that they can easily be disconnected after closing appropriate valves to prevent opening of said ducts to the outside air. The rabbled arms can then be picked up by suitable means such as a truck having two projecting fingers to enter on opposite sides of the partition and means acting through said fingers to lift the rabbled arm. The rabbled arm is then moved sidewise to a port having a door which has been opened for sidewise movement of the rabbled arm into the port preparatory to withdrawing the arm from the furnace.

Another rabbled arm may be placed in the position vacated by the arm thus removed, and connected with the supply and discharge air ducts. The opening around the outer end of the rabbled arm may then be closed in any suitable manner.

According to a second embodiment of the invention the rabbled arms are supported in the same manner as for the first form and at their inner ends are adjacent to a round pier or deadman on the rotatable hearth and occupying space beneath the gas outlet in the roof of the furnace. In this form the material to be treated is supplied at the periphery of said pier and is gradually worked by the rabbled arms to the periphery of the hearth where it is discharged downwardly and fed gradually through a gas seal to a discharge position. The central pier prevents movement of...
the material to a central area from which it would not be removed.

According to a third form of the invention the stationary pier at the center of an angular rotary hearth and the rabble arms used for this form are not only mounted at the wall of the furnace as before but are also supported at their inner ends by said stationary pier.

Other objects, features and advantages will appear upon examination of the following detailed description and of the furnace, in which:

Fig. 1 is a section along line 1—1 of Fig. 2;

Fig. 2 is a top plan view in which certain parts of the furnace roof are broken away (line 2—2 of Fig. 1);

Fig. 3 is a fragmentary view showing a port and gate at one side of the outer end of a rabble arm so that when the rabble arm is to be removed, the adjacent door is opened, the arm may be lifted, moved to one side into the port, and then be withdrawn from the furnace.

Fig. 4 is a vertical section of a modified form of the furnace shown in Fig. 1, wherein there is a central projection from the upper surface of the hearth and the material is supplied to the hearth at the side of said central projection and is discharged at the periphery of the hearth.

Fig. 5 is a fragmentary plan view partly in section, of the furnace shown in Fig. 4 (line 5—5 of Fig. 4);

Fig. 6 is a vertical section of a third form of furnace wherein there is a central fixed support projecting upwardly through a central opening of the rotary hearth and the material is supplied near the center of the hearth and is fed outwardly by means of the rabble arms;

Fig. 7 is a fragmentary plan view of the structure shown in Fig. 6 (line 7—7 of Fig. 6) and Fig. 8 is a fragmentary view showing a modified form of the structure shown at the lower right in Fig. 1.

Referring to the drawings, there is illustrated in Figs. 1, 2 and 3 a furnace 10 having a peripheral wall 11 of generically cylindrical form and a top 12 having a central opening 13 through which gases from the furnace are discharged upwardly through a duct 14. Said top is relatively low to assure contact to the hot gases with the material on a revolving hearth 15. Perpendicular wall 11 may be made entirely of refractory material or may be made mainly of other material and lined with refractory material. Insulating material may be placed at the outside of said wall 11 and this insulating material may be enclosed by a casing of metal, brick or other suitable material. The rotary hearth 15 has at its center a discharge duct 16, preferably conical in shape from which the treated material may pass downwardly into a stationary discharge duct 17 through a gas seal 18 including a downwardly extending flange 19 carried by the discharge duct 16 and a channel 20 secured to the top of the stationary duct 17. Said channel 20 contains ashes or other suitable material into which said flange 19 projects.

Projecting inwardly from the wall 11 are rabble arms 21 which extend to the periphery of the discharge duct 17. Each of these rabble arms 21 is provided with blades 22 so inclined that as the hearth 15 rotates in clockwise direction (Fig. 2), material fed to the outer edge of the rotary hearth through a duct 23 in the side wall 11, will be rabbled from the outer edge of the rotary hearth to the central discharge duct 16. Obviously the inlet duct 23 might be replaced by a duct passing through said roof 12. The flow of material through the duct 23 is controlled by a valve 24.

The outer end of each rabble arm extends through an opening in the wall 11 and preferably is connected just outside the wall to an upright post 25 supported by the base 26 of a leg 27 formed as a downward extension of wall 11 of the hearth and in turn supported by a foundation 28. This arrangement relieves the wall 11 of the strain of supporting a heavy rabble arm entirely by connection with its outer end.

To provide such support for an arm 21 there is provided on the post 25 a member 29 in which is a semi-circular seat 30 into which the reduced and rounded outer end of the rabble arm 21 fits. Said outer end of the rabble arm may be held in said semi-circular seat or recess 30 by means of an additional member or clamp 31 having a semi-circular recess 31a receiving the opposite side of the rabble arm from that engaged by the member 29, the two parts being clamped together by any suitable means such as bolts (not shown).

At one side of the holding means for the outer end of the rabble arm there is a port comprising a doorway 32 to facilitate the insertion or removal of a rabble arm. This doorway is normally covered by a door 33 on hinges 34 and normally held closed by pivoted arms 35 engaging cams 36 on the door 33. At the side of said doorway opposite said hinges the port has an extension 37 in which the end of a rabble arm is normally located. This extension 37 is necessary to enable either removal or insertion of a rabble arm. When there is a rabble arm in position adjacent said doorway and the furnace is in use, it is important to close the opening through the furnace wall at that point. A special piece of refractory material may be used for this purpose. When a rabble arm is to be removed, the special piece must be removed to enable sidewise movement of the arm to the adjacent special furnace door.

For cooling purposes, each rabble arm 21 is hollow and is divided into two parallel ducts by a partition 38 (Fig. 3) whose inner end is spaced from the inner end of the hollow portion of the rabble arm so that air or other cooling fluids may be passed into the rabble arm at one end of the said partition and out of the arm at the opposite side of said partition. Cooling air may be supplied under pressure to each rabble arm 21 from a supply duct or pipe 39 extending around the furnace and after passing through the rabble arm with consequent rise in temperature may be discharged into a discharge duct or pipe 40 extending around the furnace.

The supply duct 39 is connected to the rabble arm at one side of the partition 38 by means of a pipe section 41 having a valve 42 therein, a flexible pipe section 43 and a pipe section 44 detachably connected to the rabble arm in any suitable manner. In like manner discharge duct 40 is connected to the rabble arm at the other side of partition 38 by a pipe section 45 having a valve 46 therein, a flexible pipe section 47 and a pipe section 48 detachably connected to the rabble arm in any suitable manner.

In order to remove a rabble arm 21 from the furnace, the valves 42 and 46 may be closed, and the pipe sections 44 and 48 detached from the arm and then moved to one side as permitted by the flexible pipe sections 43 and 47. This will expose the end of the rabble arm 21, shown in Fig. 3. Then the rabble arm may be engaged by a suitable lifting device (not shown) having
fingers to insert into the passages on opposite sides of partition 38. Then after removing the sealing material in the extension of the door frame 32, opening the door 33, and removing the clamp member 31, the rabble arm may be lifted from its seat on member 29, shifted over into said doorway and then drawn out of the furnace. During this removal and substitution of another rabble arm, there will be a draft action and also generation of pressure to offset the draft effect. Consequently the furnace action will remain substantially the same as usual. The furnace will of course be provided with burners 56. The hearth 15 comprises an upper part of refractory material supported by a metal frame 51 having a downwardly extending tubular part 52 resting upon ball bearings 53 carried by a cylindrical member 53' supported by said foundation 28. The upper ring 54 of said ball bearing 53 is formed like a worm gear and may be operated by a worm 55 to turn the hearth 15. At its circumference the hearth 15 is provided with an upwardly extending rib 58 which lies beneath a downwardly facing shoulder 57 of the inner face of the peripheral wall 11. This arrangement tends to prevent material from the inlet duct 23 from escaping over the circumference of the hearth. Flow of gases around the edge of the hearth is guarded against by a gas seal 56 comprising a trough 59 at the inner face of the wall 11 and a flange 60 projecting downwardly from the outer edge of the hearth into suitable material in the trough, such as sand, ashes, or any material escaping from the interior of the furnace over the edge of the hearth. The feature of supporting the trough 59 on the wall 11 at the inner face thereof enable the use of a wider trough 59 than could be used if the trough were fixed to the outer edge of the revolving hearth, unless of course the clearance between the edge of the revolving hearth 15 and the wall 11 were increased as by reducing the radius of the revolving hearth. The flat arch top 12 of the furnace may be reinforced or supported in any suitable or well known manner.

In the apparatus of Figs. 1, 2 and 3, the flow of the material is concurrent with that of the gases and the temperatures of the burning gases decrease and of the material increase toward the outlet. A second embodiment of the invention is illustrated in Figs. 4 and 5. The surrounding wall 11a, the rabble arms 21a, the rabble arm supports and connections are substantially the same as the corresponding parts of Figs. 1, 2 and 3.

However, the hearth 15a turns in the opposite direction, that is counterclockwise and the treated material is discharged at the outer edge or circumference of the hearth. Consequently the material to be treated is supplied through a duct 23a close to the gas discharge duct 14a at the center of furnace top 12. The flow of material through supply duct 23a is regulated by a valve 24a. In this form of apparatus the hearth 15a is provided with a central upward projection 16a to restrain the flow of hot gases to the gas outlet and to prevent material falling from the duct 23a from collecting on a central portion of the top of the hearth 15a where it could not be reached by the rabble arms. Preferably said central projection 16a is of frusto-conical shape. In this form the flow of the material is counter-current to that of the burning gases.

There is of course no attempt to prevent discharge of material over the outer edge of the hearth but there is a gas seal 58a comprising a flange 59a extending downwardly from the edge of the hearth into a trough 59a carried by the wall 11 of the furnace and normally containing overflow material. The material is discharged at on side of the furnace through a duct 17a. The trough 59a is preferably provided with a fin 61a to level off the material in the trough. In this form of apparatus, the support of the trough 59a from the wall 11a is particularly advantageous because material in the trough 59a can be discharged directly from the trough 59a into the fixed duct 17a and maintain a minimum level of material in the peripheral running seal. Figure 5 shows one rabble arm positioned directly in line with the discharge duct 17a and the rabble tooth or deflector adjacent to the peripheral wall on this arm would be positioned to discharge the material from the peripheral discharge area of the hearth directly to duct 17a. This arrangement minimizes the amount of material which might otherwise accumulate in the seal 55a and facilitates withdrawing the material from the hearth directly to the discharge chute thus eliminating possibility of the material changing by the slow cooling it would receive if it first dropped into trough 59a. This design hearth also eliminates the necessity for a peripheral rib such as 55 shown in Fig. 1. This contributes to a more durable furnace as such a rib is susceptible to frequent damage by use.

A third embodiment of the invention is illustrated in Figs. 6 and 7. The hearth 15b is annular and has an upwardly projecting rim 15c around its central opening. The central opening is occupied by circular head 16c of a stationary pier 14b and said head 16c has a top 16d overhanging said rim 15c and serving to support the inner ends of arms 21b which are longer than the arms 21a of Fig. 4. The annular opening between the bottom of head 16c and the inner surface of the central opening of hearth 15b is closed by a suitable seal 18b. The hearth 15b is rotated by substantially the same means as the hearths 15 and 15c of the other two forms.

Fig. 8 illustrates the manner in which a peripheral wall 11c can be supported on brackets 23d on posts 23c. This arrangement provides for easy access to a gas seal 53c comprising an outwardly facing trough 59c attached to the outer edge of hearth 15d and a flange 60c projecting downwardly from wall 11d. This form of support and the corresponding seal may be applied to the furnace of Figs. 1, 2 and 3.

It will be evident that the various embodiments of the invention, disclosed herein, have many important novel features. Of particular importance are the common features of using rabble arms extending inwardly from the peripheral wall, arrangements whereby said rabble arms may readily be removed and inserted, and connections between said rabble arms and air supply and air discharge ducts or manifolds, including shut-off valves adjacent the manifolds and detachable connections with the rabble arms. It should be understood that various changes can be made and that various features can be used without others, without departing from the true scope and spirit of the invention.

What is claimed is:

1. A furnace comprising a peripheral wall, a bottom in the form of a rotary hearth, a gas seal.
between the edge of the hearth and said wall, a fixed roof having a central gas outlet, a fixed material inlet to supply and distribute material to an outer annular discharge area, a fixed feed inlet to said wall, and carrying rabbles to move the material radially on said hearth and said receiving area to said discharge area, a fixed material outlet, and a fixed deflector to move said material from said discharge area to said material outlet, means outside said peripheral wall for detachably supporting said rabbles arm assembly, a passageway through said peripheral wall to accommodate said rabbles arm assembly, a passageway through said peripheral wall to accommodate said rabbles arm assembly, and replacing said rabbles arm assembly from without said furnace, and separate means for closing the remaining passageway.

6. A continuous rabbles furnace according to claim 5 including a running seal between said peripheral wall and the core of said hearth to reduce air infiltration.

7. A continuous rabbles furnace according to claim 5 wherein said rabbles arm is cooled by circulating cooling fluid through internal duct passages thereof communicating with cooling fluid supply and discharge ducts by detachably connecting joints provided at the outer end of said rabbles arm.

8. A continuous rabbles furnace comprising a circular peripheral wall, an enclosing roof having a central gas outlet, a circular rotary hearth serving as the furnace bottom and having an outer annular receiving area and a central discharge port, a fixed inlet to supply and distribute material to said receiving area, a stationary rabbles arm assembly projecting outwardly from outside said peripheral wall and carrying rabbles to move the material radially on said hearth from said receiving area to said discharge port, means outside said peripheral wall for detachably supporting said rabbles arm assembly, a passageway through said peripheral wall to accommodate said rabbles arm assembly, and replacing said rabbles arm assembly from without said furnace, and separate means for closing the remaining passageway.

9. A continuous rabbles furnace comprising a circular peripheral wall, an enclosing roof having a central gas outlet, a circular rotary hearth serving as the furnace bottom and having an outer annular receiving area and a central discharge port, a fixed inlet to supply and distribute material to said receiving area, a stationary rabbles arm assembly projecting outwardly from outside said peripheral wall and carrying rabbles to move the material radially on said hearth from said receiving area to said discharge port, means outside said peripheral wall for detachably supporting said rabbles arm assembly, a passageway through said peripheral wall to accommodate said rabbles arm assembly, and replacing said rabbles arm assembly from without said furnace, and separate means for closing the remaining passageway.

10. A continuous rabbles furnace according to claim 9 including a running seal between said peripheral wall and the core of said hearth to reduce air infiltration.

11. A continuous rabbles furnace comprising a circular peripheral wall, an enclosing roof having a central gas outlet, a circular rotary hearth serving as the furnace bottom and having an outer annular receiving area and an outer annular discharge area, a fixed feed inlet to said wall, and carrying rabbles to move the material radially on said hearth from said receiving area to said discharge area, a fixed material outlet and a fixed deflector to move said material from said discharge area to said material outlet, means outside said peripheral wall for detachably supporting said rabbles arm assembly, a passageway through said peripheral wall to accommodate said rabbles arm assembly, and replacing said rabbles arm assembly from without said furnace, and separate means for closing the remaining passageway.

12. A continuous rabbles furnace comprising a circular peripheral wall, an enclosing roof having a central gas outlet, a circular rotary hearth serving as the furnace bottom and having an outer annular receiving area and an annular discharge area, a fixed inlet to supply and distribute material to said receiving area, a stationary rabbles arm assembly projecting inwardly from outside said peripheral wall.
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9. Assembly from without said furnace, and separate means for closing the remaining passageway.

13. A continuous rabble furnace according to claim 12 including a running seal between said peripheral wall and the correlative extremity of said hearth, and means to continuously maintain a minimum level of material in said running seal.

14. A continuous rabble furnace according to claim 12 wherein said rabble arm is cooled by circulating cooling fluid through internal duct passages thereof communicating with cooling fluid supply and discharge ducts by detachable connecting joints provided at the outer end of said rabble arm.

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