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REGENERATIVE OPEN HEARTH FURNACE SYSTEM

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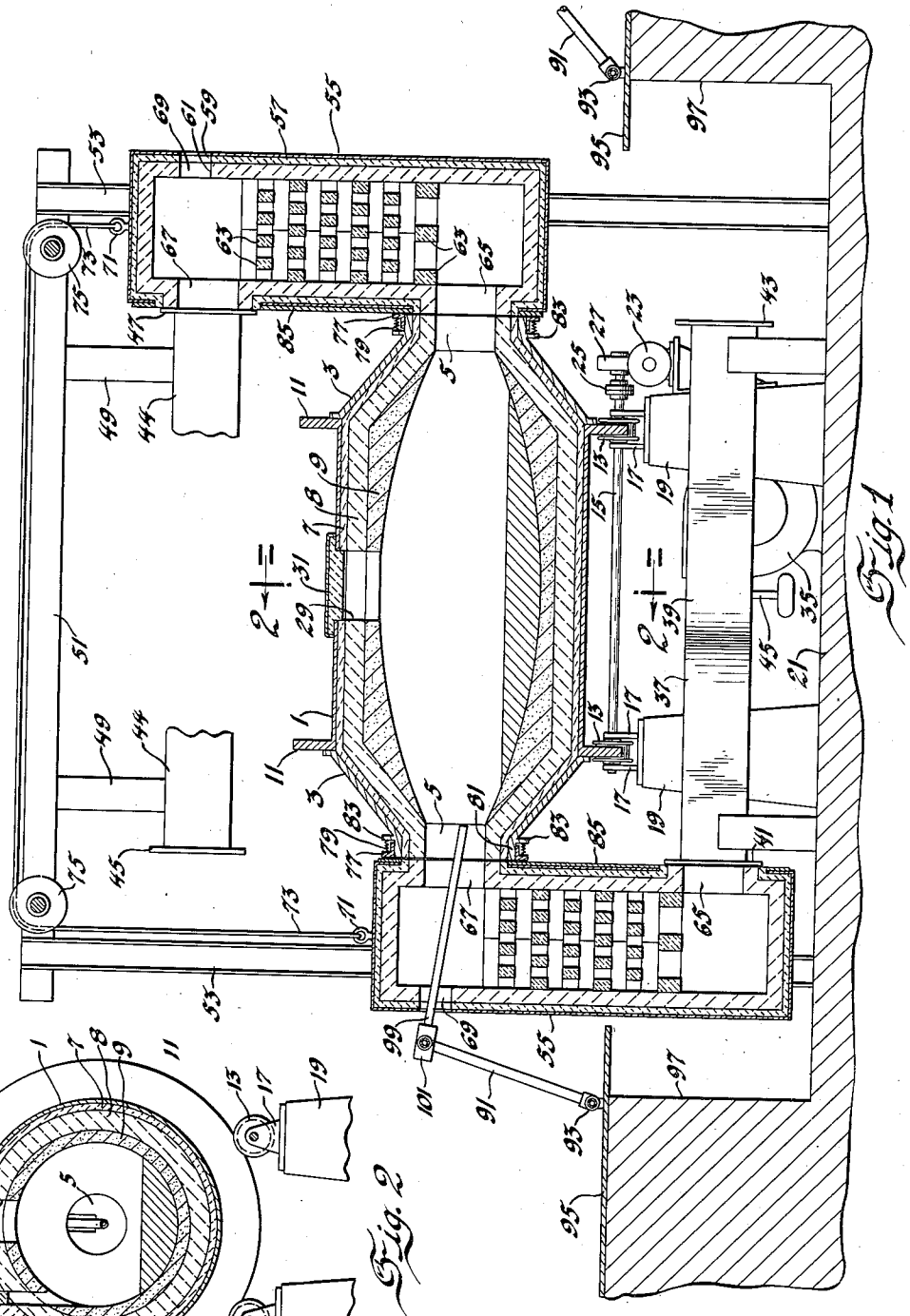


Fig. 1

Fig. 2

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REGENERATIVE OPEN HEARTH FURNACE SYSTEM

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9 Claims. (Cl. 263—16)

My invention relates to open hearth furnace systems and more particularly to a regenerating system for use with metal treating furnaces.

It is an object of my invention to provide a regenerating system of improved thermal and mechanical efficiency for applying the heat of the exhaust gases of furnaces to preheat the ingoing air.

It is a further object of my invention to provide such a system which is especially suitable and efficient for installation and use with reversely blown open hearth furnaces of the rolling type of construction.

It is also an object of my invention to provide an open hearth furnace regenerating system wherein heat-storing checkers having vertically spaced ports, are moveably supported in counterbalanced relation for simultaneous movement in vertical directions to position the parts for operatively inter-connecting between blower ports, furnace ports and stack ports whereby the gases passing to and from the furnace, flow unidirectionally through the checkers in interchangeable order while they pass in reversible directions through the furnace.

The invention itself, however, both as to its arrangement and its method of operation together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawing, in which:

Figure 1 is an elevational view, partly in section, illustrating a rolling open-hearth furnace arranged with a regenerative heating system in accordance with my invention; and

Figure 2 is a sectional view on line 2—2 thereof.

Referring more particularly to Figure 1 of the drawing, I have illustratively disclosed my invention in operative association with an open hearth furnace of the rolling type although it will be understood that in its broader aspects the principle of my invention is also applicable to other types of furnaces, both movable and stationary. The rolling type of furnace, as shown, comprises a substantially cylindrical outer shell 1 of sheet metal having its opposite ends restricted and partially closed by frusto-conical caps 3 of sheet metal providing open end ports 5 in the center. The end caps 3 are secured to the cylindrical shell 1 in any well known manner as by welding or riveting, and the entire structure is suitably lined with refractory materials in a manner well known in the art. The linings are provided in several layers 7, 8 and 9 to provide suitable heat insulating and resisting properties in the usual manner and the innermost layer 9 of the lining is a temporary coating which is applied at the beginning of the heat. The opposite ends of the cylindrical shell 1 are provided with laterally projecting flanges 11 comprising guide rails which rest upon flange wheels 13 for rotatively supporting the furnace. The wheels 13 and rails 11 may be smooth or cogged as desired. The flange wheels 13 are operatively secured upon a shaft 15 which extends through both of them and which is journalled in bearings 17 supported upon columns 19 rising from the floor 21. One end of the shaft 15 is operatively connected to a source of power 23 such as an electric motor through suitable coupling means which may comprise a friction clutch 25 and suitable speed reducing gears 27. As shown in Figure 2, two flange wheels 13 are provided in circumferentially spaced relation for supporting each end of the furnace.

In the side wall of the furnace is provided a suitably plugged spout 28 for tapping the furnace and a loading opening 29 which extends through the steel shell 1 and the various layers of heat-resisting linings for loading the furnace. For tapping the furnace to draw the molten metal, the plug is removed from the spout 28 and the motive means 23 is operated to rotate the wheels 13 which thereby rotates the furnace and turns the spout 28 to the lower-most position.

When the furnace is in operation, the motive means 23 is suitably controlled to rotate the furnace and turn the spout 28 to an upper position at which time its plug is inserted and the loading opening 29 is suitably closed, for instance, it may be covered by a hinged cover plate 31 secured in any suitable manner as by a bolt 33. The cover plate and the spout plug thus prevent the escape of gases from the furnace, as will be readily understood.

For supplying fresh air for combustion in the furnace blower unit 35 of usual construction is provided and is operatively connected through suitable conduits 37 and 39 with blower port members 41 and 43. In order that the blower unit 35 may be operatively connected selectively with either one of the blower port members 41 or 43 it is connected to either one of the conduits 37 or 39 through a selective two-way valve controlling means 45 which may be of any well-known construction. The exhaust gases from the furnace are carried away through stack vent means 44 terminating in suitable stack port members 45 and 47 and supported by suitable brackets 49 depending from a frame comprising

a horizontal beam 51 and a pair of vertical beams 53 rising from the floor. The blower and stack port members are arranged in vertically spaced relation at substantially equal distances above and below the furnace ports 5.

For operatively connecting one of the blower ports 41 and 43 with one of the furnace ports 5 and the other furnace port 5 with one of the stack ports 45 or 47 a pair of heat-storing checker members 55 are movably associated therewith. Each of the checkers 55 comprises a sheet-metal enclosure 57 which is lined with successive layers 59 and 61 of heat insulating material and heat resisting lining in a manner similar to the construction of the furnace. In the enclosed space a series of layers of checker brick-work are provided in vertically spaced positions for passing gases therethrough in intimate heat-exchanging relation. For this purpose the checker brick-work may be composed of fire bricks 63 arranged in staggered relation whereby the flow of gas is alternately diverted about the respective bricks thereby causing it to flow in intimate heat-exchanging relation. Each of the checker receptacles 55 is provided with a pair of vertically spaced ports 65 and 67 extending through the side wall thereof. The lowermost port 65 in each of the checkers comprises an inlet port and the uppermost port 67 comprises an outlet port. A small aperture 69 is also provided through the side wall of each of the checkers opposite the upper or outlet port 67, for a purpose to be subsequently set forth.

Each of the checkers is provided with a suitable ring or eyelet 71 by means of which it is supported for vertical movement adjacent the furnace. For this purpose a flexible member 73 such as a steel cable is inter-connected between the eyelets 71 of the checkers and passes over suitable pulleys 75 journalled in the upward framework 51. In this manner the checkers are movably supported in counter-balanced relation and they may be moved to dispose either one of the checkers with its inlet port 65 connected with a blower discharge port and its outward port 67 connected with one of the furnace ports 5. At the same time the other checker is simultaneously moved and disposed with its inlet port 65 adjacent the other furnace port 5 and its outward port adjacent one of the stack ports.

To make a sealed connection between the furnace port 5 and the adjacent checker port a slidable sealing ring 77 is provided on each end of the furnace, and each ring is continuously biased outwardly by suitable resilient members or compression springs 79. The outermost end of each conical cap 3 is provided with a cylindrical collar 81 for slidably supporting one of the sealing rings 77, and a lateral flange 83 for receiving the runner ends of the springs 79 for biasing its associated slidable ring 77 outwardly. The sides of the checker receptacles 57 adjacent the furnace preferably carry plates 85 presenting ring engaging surfaces.

For supplying fuel to heat the furnace, a conduit 91 is pivotally mounted adjacent each end port 5 thereof where it is journalled in a suitable bearing 93 upon a plate 95 mounted upon an abutment 97. Each of the pivotally mounted fuel supply conduits 91 is provided with a fuel injecting nozzle 99 which is journalled on a flow conducting joint 101 on the end of the pivoted conduit. By this arrangement the fuel injecting nozzle 99 may be conveniently projected through the small aperture 69 in the back wall of the checker after the latter has been moved to place its outlet port 67 adjacent the furnace port 5. When the operation of the checkers is to be reversed, the fuel injecting nozzle 99 is first withdrawn by moving it away from the furnace, in any suitable manner after which the checkers are simultaneously moved to their alternate positions. The fuel injecting nozzle at the opposite end of the furnace is then inserted through the small aperture in the other checker to supply fuel for blowing the flame from the opposite port 5 of the furnace. It will be understood that both of the fuel injecting nozzles are connected through suitable pipe lines and controlling valves (not shown) with a pressure supply source of liquid or gaseous fuel. Although I have shown my system for manual control, it will be readily comprehended by those skilled in the art that motive means may be provided for intermittently operating the checkers to move them to their respective alternative positions, which operation may be automatically controlled by a temperature responsive device if desired.

In operation the motive means 23 is actuated for turning the furnace to a suitable position for opening the tap-hole 29 in the side wall thereof and by removing the man-hole cover provided thereon access to the furnace is readily obtained. The furnace may now be prepared for a run by suitably charging it in the usual manner. After the man-hole cover 31 is secured on the hole by means of the bolts, a blast of air is supplied to the furnace from the blower unit 35 by which a suitable pressure is maintained. By properly turning the cold air valve 45 the air from the blower is admitted to the intake port 65 at the lower end of whichever checker that is associated with the blower port. The air then passes upwardly through the checker along the vertical channels between the checker brick-work in intimate thermal association therewith. From the upper end of the checker the air blast passes through the outlet port 67 whence it enters the adjacent furnace port 5 and passes horizontally through the furnace. Simultaneously fuel is injected into the air blast through the nozzle 99 which extends into the furnace port 5 and supplies a stream of fuel to provide a flame of suitable conformation sent horizontally through the furnace. The ore and material which has been charged into the furnace is then heated by radiation and conduction from the flame passing over it. As the charge is melted down it settles in a molten mass on the lower walls of the furnace, as shown. The hot exhaust gases pass from the furnace port 5 at the opposite end of the furnace through the inlet port 65 of the associated checker then upwardly through the vertical channels between the checker bricks in intimate heat exchanging relation and out through the outlet port at 67 the upper end of the checker into the associated stack port. From the stack port the gases are of course carried through a vent 44 to the stack.

When the hot exhaust gases have heated the brick-work within the checker on the outlet side of the furnace to a high temperature the positions of the checkers are reversed. The cold air control valve is then also reversed to supply the cold air through the checker which was previously heated by the hot exhaust gases, and the fuel supply nozzle 99 adjacent this checker is inserted through the aperture into the adjacent furnace port 5 for supplying fuel to project the flame from the opposite end of the furnace. The fuel

and air then enter the furnace with a high initial heat and give a much higher temperature in combustion than could be obtained without preheating. At frequent intervals the course of the air and fuel is thus reversed to efficiently utilize the heat of combustion which is carried out of the furnace by the exhaust gases for preheating the incoming air and fuel.

While the furnace is being fired, its position may be altered by operating the motive means or rotating it upon its axis. This does not in any way affect its connection with the regenerative system because the ports of the furnace are arranged in alignment with the axis of rotation thereof and the connection is maintained by the sealing rings. By this arrangement the heat of the furnace may also be maintained while molten metal is being drawn through the tap-hole to a ladle which may be disposed thereunder as will be readily understood. In the operation of my system the cold fresh air and the hot exhaust gases always pass through the regenerative checker devices in the same direction by entering through the lowermost port and passing upwardly through the checker brick-work. The furnace, however, is reversely blown in intermittently opposite direction thereby heating the furnace uniformly.

It will be seen that I have provided a regenerative system for use with open hearth furnaces which is of simple construction and especially suitable for installation with rolling type open hearth furnaces by mounting the regenerative checkers in counter-balanced relation for simultaneous adjustment to their respective heating or cooling positions.

Aside from the specific embodiments of the invention herein shown and described, it will be understood that numerous details of the construction may be altered or omitted without departing from the spirit and scope of the invention as disclosed and claimed, that my invention may be utilized with other types of furnaces and that I do not desire to limit the invention to the exact construction herein set forth.

I claim:

1. The combination with a horizontally disposed furnace having spaced ports therein of means for reversely blowing said furnace and applying the heat of the exhaust gases to preheat the ingoing air comprising heat storing checkers disposed adjacent the respective ports of said furnace, each of said checkers having a plurality of ports and means for movably supporting said checkers whereby they may be simultaneously moved to dispose respective ones of their ports in selectively associated relation with the ports of said furnace.

2. The combination with a horizontally disposed furnace having spaced ports therein of means for reversely blowing said furnace and applying the heat of the exhaust gases to preheat the ingoing air comprising heat storing means disposed adjacent the respective ports of said furnace, ports in said means, stack vent means comprising stack ports, blower means comprising blower ports, and means for moveably supporting the heat storing means for movement to alternate positions whereby they may be simultaneously moved to dispose their ports in various associated relations with said blower ports, furnace ports and check ports to pass exhaust gases and ingoing air in the same direction through said means in either position of said checkers.

3. The combination with a horizontally disposed furnace having spaced ports therein of means for blowing said furnace in successively opposite direction and applying the heat of the exhaust gases to preheat the ingoing air comprising heat storing checkers disposed adjacent the respective ports of said furnace, each of said checkers having a plurality of spaced ports, blower means having blower ports for supplying air to said furnace, stack vent means having stack ports for removing the exhaust gases from said furnace, means for moveably supporting said checkers whereby they may be conveniently moved to operatively associate the various ports of said checker with said blower ports, furnace ports and stack ports whereby the gases passing to and from the furnace blow unidirectionally through the checkers in variable order.

4. In combination a furnace of substantially cylindrical conformation, means supporting said furnace for rotation on a horizontal axis, ports in said furnace in oppositely disposed axial aligned relation, means for blowing said furnace in alternately reversible directions and applying the heat of the exhaust gases to preheat the ingoing air, comprising, heat-storing checkers disposed adjacent the respective ports of said furnace, each of said checkers having an inlet port and an outlet port, means for moveably supporting said checkers whereby they may be moved to dispose either one of said checkers with its inlet port connected with one of the ports of said furnace while the other checker is disposed with its outlet port associated with the other port of said furnace.

5. In combination a furnace having spaced ports therein, means for reversely blowing said furnace in alternately reversible directions between said ports comprising heat-storing checkers disposed adjacent the respective ports of said furnace, each of said checkers having a plurality of ports associatable with the ports of said furnace, blower means comprising blower ports for providing fresh air for said furnace, stack vent means comprising stack ports for carrying the exhaust gases away from said furnace, means for moveably supporting said checkers whereby they may be conveniently moved to operatively associate the various ports of said checkers with said blower ports, furnace ports and stack ports whereby the gases passing to and from the furnace blow unidirectionally through the checkers in variable order, fuel supply means, and means for moveably supporting said fuel supply means whereby fuel may be admitted to the port of the furnace which is receiving fresh air through the associated checker.

6. In combination a furnace of substantially cylindrical conformation, means for rotatably supporting said furnace for rotation about its axis, open ports provided in opposite ends of said furnace, means for reversely blowing said furnace in alternatively reversible directions and applying the heat of the exhaust gases to preheat the indrawing air comprising heat-storing checkers disposed at opposite ends of the furnace adjacent the respective ports thereof, each of said checkers having an inlet port and an outlet port, blower means having discharge ports for supplying air to the inlet port of either of said checkers alternatively, stack vent means comprising stack ports for carrying away the exhaust gases of said furnace, and means for movcably supporting the said checkers whereby they may be conveniently

moved to dispose either one of said checkers with its inlet port connected with a discharge port of the blower and its outlet port with one of the furnace ports while the other checker is disposed with its inlet port adjacent the other furnace port and its outlet port adjacent the stack port.

7. In a regenerative system for operating a reversely blown open hearth furnace the combination of a pair of heat storing checkers, each of said checkers having a pair of vertically spaced ports, and means for supporting said checkers for vertical movement in counter-balanced relation whereby they may be simultaneously moved to interchange the connection of their respective ports with the ports of an associated furnace.

8. In combination a furnace of substantially cylindrical conformation, means for rotatively supporting said furnace in a horizontal position for rotation about its axis, spaced ports in said furnace at the opposite ends thereof, a drain opening in the side wall of said furnace, stack vent means for carrying exhaust gases away from said furnace comprising ports, blower means comprising ports for supplying fresh air to said furnace, a heat-storing checker disposed adjacent each end of said furnace, vertically spaced ports in said checker, means for moveably supporting said checkers in counter-balanced relation whereby they may be simultaneously moved to dispose either one of said checkers with its inlet port connected with a discharge port of a blower and its outlet port with one of the furnace ports while the other checker is disposed with its inlet port adjacent the other furnace port and its outlet port adjacent the stack port and moveable fuel supply means associatable with either one of said furnace ports.

9. A regenerative heat-storing checker comprising a receptacle having vertically spaced ports, heat-storing means disposed between said ports for intimate thermal association with gases passed therebetween, and means on the upper end of said receptacle whereby it may be suspended in a vertically supported position.

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