ABSTRACT: A blast furnace hearth composed of a plurality of horizontally disposed layers of carbonaceous material enclosed within a metallic peripheral cooling member. Lowermost layer is preferably graphite and outermost extremities thereof are in heat-conducting abutment with inner surface of cooling member. Construction joints, if any, are composed of carbon paste and are diametrical, not peripheral, and can contain thermocouples.
BLAST FURNACE HEARTH

BACKGROUND OF THE INVENTION

The present invention relates generally to a blast furnace hearth and more particularly to a blast furnace hearth composed of a plurality of layers of carbonaceous material. As used herein, the term "carbonaceous material" includes carbon and graphite.

Typically, a blast furnace hearth comprises, for example, three or more layers of carbonaceous material each composed of elongated carbon blocks. More recently, hearths have been designed with a lowest layer composed of graphite; and this is disclosed in MacPherson et al., U.S. Pat. No. 2,673,083, in Stahl und Eisen, Vol. 88, pp. 548—559, May 30, 1968, and in 33—The Magazine of Metals Producing, Aug., 1968, pp. 83—87.

Conventionally, the blocks of carbonaceous material in a hearth layer are arranged in a side-by-side relationship and are held in place by a construction joint composed of carbon paste and rammed into place around the periphery of the hearth layer between the inner surface of a vertically extending cooling member defining the periphery of the hearth and the outer extremities of the blocks.

Blast furnace hearth layers composed of carbonaceous material and constructed in the conventional manner described above have a number of drawbacks; and these drawbacks are especially significant when a lower layer or two is composed of graphite rather than carbon.

The better heat-dissipating properties of the hearth material, the cooler is the hearth and the longer is its life. Graphite has heat-dissipating properties many times greater than either carbon or the carbon paste of which the construction joint is composed. Heat is dissipated from the center toward the periphery of a blast furnace hearth. Therefore, although heat would be dissipated from the center toward the periphery of a hearth layer much more readily in a layer composed of graphite than in a layer composed of carbon, the carbon-paste construction joint around the periphery of the graphite layer obstructs correspondingly rapid conduction of heat from the outer extremity of the graphite layer to the inner surface of the peripheral cooling member.

In addition, the peripheral construction joint is relatively inconvenient to install because it is located immediately adjacent the inner surface of the cooling member where working space is cramped and where ramming a tight joint is relatively difficult.

SUMMARY OF THE INVENTION

The drawbacks in conventional blast furnace hearths, described above, are eliminated in a blast furnace hearth constructed in accordance with embodiments of the present invention.

Preferably, at least the lowermost layer or two of the blast furnace hearth is composed of graphite, and the outermost extremities of the graphite layer are in direct heat-conducting abutment with the inner surface of the peripheral cooling member. There is no peripheral construction joint. The only construction joints in the layer, if any, extend diametrically across the layer from one point on the periphery of the layer through the center thereof to another point on the periphery. The diametrical construction joints do not interfere with heat conduction from the graphite layer to the peripheral cooling member.

Installation of the diametrical construction joint is much easier than installation of a peripheral one. This is because the location of the diametrical joint is not crowded against the inner surface of the shell as is the peripheral joint.

The diametrical construction joint also readily lends itself to the installation of thermocouples at radially spaced locations along the joint for sensing the temperature within the blast furnace hearth.

Other features and advantages are inherent in the structure claimed and disclosed or will be apparent to those skilled in the art from the following detailed description in conjunction with the accompanying diagrammatic drawing.

DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary sectional view of an embodiment of blast furnace hearth constructed in accordance with the present invention.

FIG. 2 is a plan view of the uppermost of three layers of carbonaceous material making up the blast furnace hearth.

FIG. 3 is a plan view of the middle layer.

FIGS. 4—8 are plan views of various embodiments of the lowermost layer; and

FIG. 9 is a fragmentary sectional view illustrating a stave-type peripheral cooling member for the hearth.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1—4, a blast furnace hearth is indicated generally at 10 and comprises an upper layer 12, a middle layer 13 and a lower layer 14, all composed of elongated blocks of carbonaceous material. The hearth may include more than three layers of carbonaceous material. The layers are all enclosed within a vertically extending metallic shell portion 11 having an inner surface 16 defining the periphery of the blast furnace hearth. Shell portion 11 is spray-cooled and constitutes a peripheral cooling member for the hearth. Each layer occupies a major portion of the area defined by shell portion 11. Lowermost layer 14 rests atop a base 15, composed of refractory brick, resting on a plate 60.

Upper layer 12 is composed of a plurality of elongated carbon blocks 20 arranged side by side, separated by longitudinal seams 22 and keyed together by graphite rods 19.

Middle layer 13 is composed of a plurality of elongated carbon blocks 23 arranged side by side, separated by longitudinal seams 25 and keyed together by graphite rods 29. The blocks 23 of the middle layer extend transversely or nonparallel to the blocks 20 of the upper layer and so do middle layer seams 25, relative to upper layer seams 22.

In the embodiments illustrated in FIGS. 4—7, the lowermost layer is composed of a plurality of elongated, mutually adjacent graphite blocks 30, 40 with adjoining blocks being separated by longitudinal seams 34.

In the embodiment of FIG. 4, the blocks are arranged in an essentially radial disposition, and the blocks in lower layer 14 extend transversely or nonparallel to the blocks in either the middle layer 13 or the upper layer 12; and so do lower layer seams 34 relative to seams 32, 25 and seams 22 in the middle and upper layers respectively. Arranging the blocks of the various layers in nonparallel relative dispositions minimizes downward leakage of molten metal through the seams of successively descending layers. For example, assuming molten metal has leaked downward through seams 22 of the upper layer, once having leaked to the bottom of upper layer 12 the molten metal does not encounter a parallel or aligned seam through which it can readily continue its downward leakage.

Upper layer 12 and middle layer 13 are surrounded by a peripheral construction joint 21 composed of carbon paste. Because the conductivity of carbon paste is essentially the same as that of the carbon blocks in layers 12 and 13, there is no problem, with respect to heat dissipation, arising from the use of a peripheral construction joint in the upper and middle layers. On the other hand, lower layer 14 is composed of graphite blocks having heat dissipation properties many times greater than carbon blocks or carbon paste. Accordingly, there is no peripheral construction joint composed of carbon past surrounding the lower layer in the embodiments of FIGS. 4—7. Instead, the outermost extremities 33 of graphite blocks 30, 40 are in direct, heat-conducting abutment with the inner surface 16 of outer metallic shell portion or cooling member 11. The construction joints in lower layer 14 are diametrically extending construction joints 31, 32 each extending from one
3,599,951

point on the periphery of the layer through the center thereof to another point on the periphery opposite the first point. Because construction joints 31, 32 are diametrical rather than peripheral, they are easier to install, and it is easier to ram a tight joint. Joints 31, 32 also provide a convenient location for installation of thermocouples 35 located at radially spaced positions along the construction joints to monitor temperature conditions within hearth layer 14.

In the embodiment of Figure 1, shell portion 11 is cooled by a stream of water trickling downwardly along the outside of the shell from a tube-like trickle nozzle 36. The cooling liquid, typically water, is caught at the bottom of shell portion 11 in a trough 37. Other conventional shell cooling expedients may be used, e.g., a jacket-cooled shell; or the peripheral cooling member may be cooling staves 50 located inside the furnace shell 61 (Figure 9). A cooling fluid is circulated through the cooling staves via inlet and outlet conduit 62.

The vertical dimension of fluid-cooled shell portion or cooling member 11 should coincide with at least the vertical dimension of those hearth layers composed of graphite (e.g., layer 14 in FIG. 1) and preferably should coincide with the full vertical dimension of the blast furnace hearth, i.e., of layers 12, 13, 14.

From the standpoint of heat dissipation in a blast furnace hearth, the optimum shape for a layer of carbonaceous material would be a monolithic disc without seams. Wherever seams occur, heat dissipation is obstructed. The monolithic disc would be the layer 14 of Figure 8 but without the seams 41 and without construction joints 31, 32.

After the monolithic disc, the next best shape would be a layer composed of a minimum number of pie-shaped segments or blocks. Heat dissipation in a blast furnace hearth is radial from the center of a layer toward the periphery thereof, and a pie-shaped segment would promote this type of heat dissipation.

Referring to Figure 8, construction joints 31, 32 divide the lower layer into a relatively small number of pie-shaped segments or quadrants 38 each defined on opposite sides by construction joints 31, 32. Desirably, each pie-shaped segment 38 should be in one piece. If this arrangement is not practicable, then a segment 38 composed of a minimum number of smaller pie-shaped segments 39 would be the next best shape.

Another arrangement is illustrated in Figure 4 wherein layer 14 is composed of a plurality of elongated blocks at least one of which 40 extends radially from the center of the layer toward the periphery thereof along the middle portion of the pie-shaped segment 38. Other blocks 30 in segment 38 extend parallel to block 40. Elongated blocks of carbonaceous material are conventionally extruded; and, in these blocks, heat dissipation transverse to the longitudinal dimension of a block is only about two-thirds of the heat dissipation in the longitudinal direction which is also the direction of extrusion. The radial arrangement of blocks 30, 40 illustrated in FIG. 4 provides a maximum utilization of the directionality of heat dissipation in the blocks.

Other arrangements of graphite blocks 30, 40 for lower layer 14 are illustrated in FIGS. 5—7.

In all of the embodiments illustrated in FIGS. 4—8 a pair of mutually intersecting, diametrically extending construction joints 31, 32 are used. With such a diametrical arrangement, the amount of carbon paste used in the construction joints is only about two-thirds of what would be used if the construction joints were peripheral, assuming the width of the joints is the same.

Although, in the embodiments described above, only lowermost layer 14 is composed of graphite, any number of lower layers could be composed of graphite, or any number of layers could be composed of carbon. At least the top layer should be composed of carbon. Preferably, at least the bottom layer is composed of graphite. Any number of lower layers below the top two layers could have the monolithic disc-like arrangement or the pie-shaped or segmented arrangements of FIGS. 4—8, discussed above in connection with lower layer 14. The top layer or two should have the keyed type of construction shown in FIGS. 2 and 3. A keyless construction can be used for layers below the top two layers.

The foregoing detailed description has been given for simplicity and clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What I claim is:

1. A blast furnace hearth comprising: a vertically extending, metallic cooling member defining the periphery of said hearth; and a horizontally disposed layer of carbonaceous material located within said cooling member and occupying a major portion of the area defined by said cooling member; said layer of carbonaceous material having an outer peripheral surface in direct, heat-conducting abutment with the inner surface of the cooling member along substantially the entire periphery of the hearth; said hearth being devoid of a construction joint around the periphery of said layer; a plurality of construction joints extending across said layer from the center thereof to a point on the periphery of said layer, said joints dividing said layer into a plurality of pie-shaped segments, each extending from the center to the periphery of said layer; and, each of said pie-shaped segments is composed of at least one pie-shaped block.

2. A blast furnace hearth as recited in claim 1 and comprising at least one thermocouple located in said construction joint.

3. A blast furnace hearth as recited in claim 1 wherein: said metallic cooling member is fluid cooled and said cooling member extends along a vertical dimension coinciding with the vertical dimension of said hearth.

4. A blast furnace hearth as recited in claim 1 wherein: said layer of carbonaceous material is composed of graphite; and said cooling member has a vertical dimension coinciding with the vertical dimension of said graphite layer.

5. A blast furnace hearth as recited in claim 1 and comprising: at least two layers of carbonaceous material superimposed on said first-recticed layer; each layer comprising a plurality of elongated blocks arranged in side-by-side disposition with longitudinal seams between adjacent blocks; said longitudinal seams in the bottom of the three layers extending in nonparallel relation to the longitudinal seams in any of the two upper layers.

6. A blast furnace as recited in claim 1 wherein said carbonaceous material consists of graphite.

7. A blast furnace hearth as recited in claim 1 wherein: said layer is a monolithic disc without seams and without a construction joint.

8. A blast furnace hearth comprising: a vertically extending, metallic cooling member defining the periphery of said hearth; and a horizontally disposed layer of carbonaceous material located within said cooling member and occupying a major portion of the area defined by said cooling member; said layer of carbonaceous material having an outer peripheral surface in direct, heat-conducting abutment with the inner surface of the cooling member along substantially the entire periphery of the hearth; said hearth being devoid of a construction joint around the periphery of said layer; a plurality of construction joints extending across said layer from the center thereof to a point on the periphery of said layer, said joints dividing said layer into a plurality of pie-shaped segments, each extending from the center to the periphery of said layer;
5 each of said pie-shaped segments comprising:
at least one elongated block extending radially from the
center of said layer toward the periphery thereof along a
middle portion of the pie-shaped segment; and,
a plurality of other blocks extending parallel to said one 5
block on each side thereof.
9. A blast furnace hearth comprising:
a vertically extending, metallic cooling member defining the
periphery of said hearth;
and a horizontally disposed layer of carbonaceous material 10
located within said cooling member and occupying a
major portion of the area defined by said cooling
member;
said layer of carbonaceous material having an outer

6 peripheral surface in direct, heat-conducting abutment
with the inner surface of the cooling member along sub-
stantially the entire periphery of the hearth;
said hearth being devoid of a construction joint around the
periphery of said layer;
construction joints for said layer of carbonaceous material
consisting of two joints each extending diametrically
across said layer transversely to the other of said two
joints;
the total length of all of the construction joints for said layer
being less than two-thirds the circumference of said layer
at the periphery of the layer.