Jan. 21, 1947. W. E. MOORE 2,414,545

FURNACE ROOF CONSTRUCTION

Filed Nov. 1, 1943 2 Sheets-Sheet 1

Fig. 1.

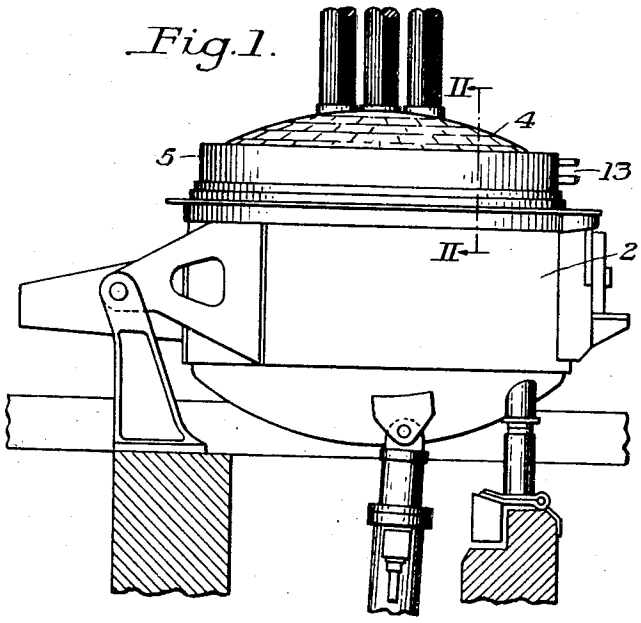
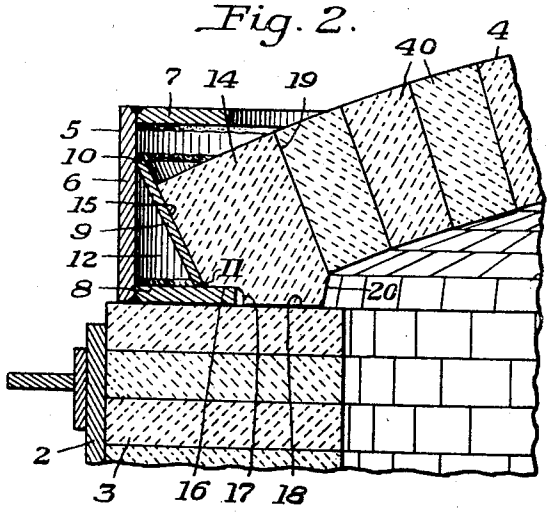


Fig. 2.



INVENTOR
William E. Moore
by Christy, Parmelee and Strickland
his attorneys.

Jan. 21, 1947. W. E. MOORE 2,414,545

FURNACE ROOF CONSTRUCTION

Filed Nov. 1, 1943 2 Sheets-Sheet 2

Fig. 3.

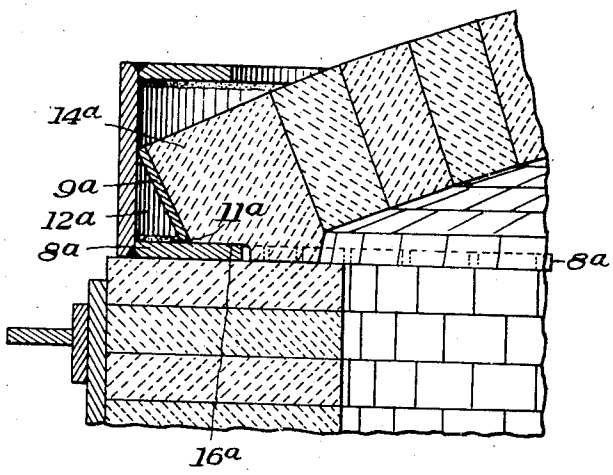
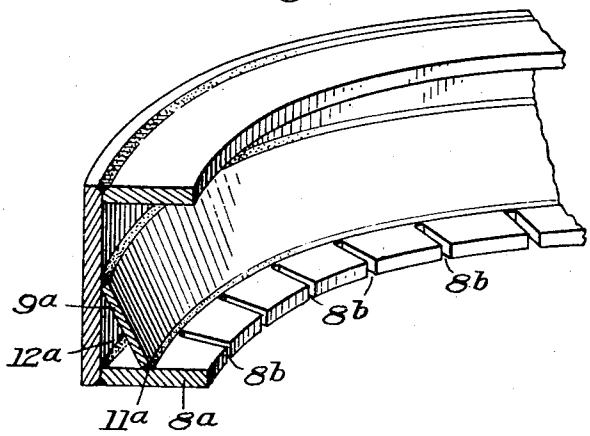


Fig. 4.



INVENTOR
William E. Moore
by Christy, Parmelee and Strickland
his attorneys

Patented Jan. 21, 1947

2,414,545

UNITED STATES PATENT OFFICE

2,414,545

FURNACE ROOF CONSTRUCTION

William E. Moore, Pittsburgh, Pa., assignor to Delaware Engineering Corporation, Pittsburgh, Pa., a corporation of Delaware

Application November 1, 1943, Serial No. 508,476

5 Claims. (Cl. 110—99)

1

This invention pertains to a roof construction for furnaces and is for a roof construction particularly designed for use in connection with electric furnaces, but is applicable to other furnaces where a refractory roof of the general type hereinafter described is required. The present application is a continuation-in-part of my copending application, Serial Number 453,383, entitled "Furnace roof construction," filed August 3, 1943.

In the electric furnace art as it is generally practiced at the present time, it is customary to make an electric furnace in cylindrical form with a spheroidal refractory roof. This spheroidal refractory roof is contained within a frame generally referred to as a roof ring. The roof assembly comprising the ring and the spheroidal arch which it supports rests upon the top of the cylindrical refractory wall of the furnace. In use, the roof may be lifted as a unit clear of the side walls for charging the furnace or for access to the interior of the furnace for other purposes.

In furnaces of this character it is expected that the side walls will burn out or disintegrate more or less rapidly, depending of course upon the character of the refractory, the character of the materials being melted, the power of the furnace, and the care of the operator. In some cases the side walls burn away so rapidly as to give continuous trouble by undercutting the roof ring, resulting not only in a waste of power due to the dissipation of heat, but resulting also in the destruction of the roof ring. To overcome this it has heretofore been the practice in some cases to provide a cooling means in the form of a substantially annular tube in the bottom interior corner of the roof ring, which ring is usually of channel-like section, having a vertical web and inwardly turned horizontal flanges, but this has proved in many instances to be inadequate due to the excessive heat and the rapid destruction of the side walls. To correct this difficulty it has been the practice in some instances to provide an inclined plate inside the ring, the lower edge of this plate being welded to the inner edge of the bottom flange of the channel and the top of the plate being welded to the vertical web of the channel. This plate provided in effect a conical support or skew back for the refractory roof. It also formed with the ring itself a water circulating chamber in the enclosed area within the ring so formed. With such a construction, however, there is a tendency for the refractory bricks to slide down the inclined surface of the skewback or for the bricks to become loosened by spalling.

2

This condition of spalling is aggravated by the concentration of radiant heat under a portion of the bottom of the outer row of bricks. Another difficulty which has been encountered with this construction is that when the underlying side wall structure burns away the welded joint between the bottom edge of the inclined plate and the inner edge of the flange of the ring is exposed to direct heat, opening the welded joint and causing frequent leaks in this welded seam. These troubles cause many delays in the operation of electric furnaces and increase maintenance cost and decrease production.

According to the present invention the ring is of the form heretofore generally employed, i. e., it is of channel shape in cross section with the horizontal flanges of the channel turned inwardly. An inclined supporting plate forming a skewback against which the refractory roof bears is provided, but this plate, instead of being welded to the lower inner edge of the bottom flange of the channel, is welded to the top surface of the bottom flange at a point between the inner edge of this flange and the web of the channel. It thus provides a conical or inclined support or seat against which the refractory roof blocks will rest and also forms a water circulating passage of relatively large cross sectional area in the ring. However the portion of the bottom flange which projects beyond the inclined plate forms a supporting ledge or secondary seat for the refractory blocks, restraining these blocks from slipping down. The blocks in turn are notched or cut away to receive this ledge or lip so that the bottom of the refractory blocks is preferably flush with the bottom of the metal ring. The weld between the lower edge of the diagonal plate and the horizontal bottom flange is thus screened from the heat of the furnace by a refractory and, in the event of the side walls under the roof being undercut, protected from direct heat through the medium of an intervening metal cooled wall. The improved construction, while of a very simple character and which results in no substantial increase in the cost of the roof, eliminates many of the difficulties which have heretofore been encountered in constructions of this kind and substantially lengthens the life of the roof and roof ring and provides a construction in which breakdowns due to leakage of the cooling water are very substantially diminished. At the same time since the refractory blocks at the rim of the refractory roof are directly supported against downward movement by an underlying ledge or lip of metal, disintegration of the roof due to

spalling or to the blocks by slipping down is also minimized, and the life of the roof is very considerably lengthened.

The nature of my invention may be more fully understood by reference to the accompanying drawings, in which:

Figure 1 is a side view of a typical electric furnace installation embodying a roof construction of my design;

Figure 2 is a view on a larger scale representing a transverse vertical section through a portion of the roof ring of the furnace of Figure 1 and the upper portion of the side wall of the furnace on which the ring rests;

Figure 3 is a view similar to Figure 2, illustrating certain modifications in the construction of the invention;

Figure 4 is a fragmentary sectional view of the roof ring of the modified construction of Figure 3.

In the drawings, a conventional form of electric furnace is illustrated, this furnace having a metal shell 2 within which is built up a refractory side wall structure 3. The roof is designated generally as 4. The particular furnace illustrated is of cylindrical shape and the top is in the nature of a spherical section, but the invention is not restricted to any particular form or shape of furnace and the term "spheroidal" as applied to the arched roof is intended to include either a circular arched roof, an oval arched roof or any generally similar shape. The roof assembly 4 comprises a roof ring designated generally as 5 which is channel shaped in cross section, having a vertical web 6 and inwardly extending horizontal upper and lower flanges 7 and 8, respectively. The ring is illustrated as being formed from sections of metal plate welded together.

According to the present invention an annular sloping plate 9 is provided within the ring 5, the upper edge of this plate being welded to the web 6 as indicated at 10. The lower edge of this inclined plate rests on top of the lower flange 8 of the ring and is welded to this ring at a point intermediate the free inner edge of the flange and the vertical web 6, this weld being designated 11. The sloping plate 9 which provides a conical interior surface for the seating of the refractory blocks, described below, may be termed a skewback plate. It forms with the web 6 and the flange 8 an enclosed annular chamber 12 through which cooling fluid may be circulated, pipes for the circulation of fluid being indicated at 13. It will be noticed that by reason of the plate 9 being welded to the top surface of the flange 8 at a point spaced inwardly from the free edge of the flange the intervening rim of the flange between the bottom edge of the plate 9 and the inner edge of the flange provides a horizontal supporting seat or ledge for supporting the refractory roof as is hereinafter more fully described. As the drawings clearly indicate this supporting ledge or seat is formed by the projection of the bottom wall of the cooling chamber 12 inward from the weld 11.

The refractory roof is comprised of concentric rows of blocks 40. The blocks of the outermost row are especially shaped for cooperation with the roof ring, these blocks being designated generally as 14. They are provided with a sloping outer face 15 which bears against the sloping skewback 9. The bottom face of each of the blocks 14 is notched out or cut away as indicated at 16, whereby the blocks overhang the supporting ledge or lip formed by the interior of the flange 8. The support thus given the blocks 14 prevents them from slipping downwardly. The notch 16 is undercut a sufficient distance so that the vertical shoulder 17 is normally spaced inwardly from the inner edge of the flange 8. This clearance space is desirable to take care of the expansion of the roof. The bottoms 18 of the blocks 14 extend down far enough so that they are at least flush with the bottom of the flange 8. The inner wall of each block has one surface 19 which is approximately parallel with the surface 15 and another surface 20 which forms an obtuse angle with the surface 19 and which is nearly vertical.

The roof assembly as thus described normally rests on the refractory side wall 3 of the furnace. The metal ring is protected by water cooling. The bottom flange 8 of the ring is protected from the direct radiation of heat by reason of the refractory blocks being recessed or notched out at 16. In the event of the side walls of the furnace undercutting the flange 8 the roof ring is less likely to be damaged because it is either directly water cooled or the ledge which projects beyond the water cooled area is an extended water cooled surface. The weld at 11, being on the top of the cooled flange 8 and being spaced outward from the inner edge of flange 8, is protected from the heat even when the side walls are badly undercut and the development of leaks due to failure of this weld is avoided. The roof blocks 14 are mechanically supported so that they can not slip down the slope of the skewback 9. The parts of the block that engage the inwardly extended ledge as well as the surface 9 are cooled and thus protected from breaking or spalling.

The modifications illustrated in the structure of Figures 3 and 4 comprise the arrangement of the skewback plate 9*a* further away from the inner edge of the flange or ledge 8*a*, thereby providing a greater area of the ledge upon which the outer course of the roof blocks is supported, as indicated at 16*a*. The cooling chamber 12*a* is located further away from the inner edge of the flange 8*a*, and the weld 11*a* is more remote from the destructive effect of furnace heat. Additionally, it is important to note that the annular ledge portion of the flange 8*a* is radially slotted at spaced-apart points 8*b* in its circumferential extent, these slots serving to relieve ring-distorting stresses that would otherwise develop under the influence of changing furnace temperatures. Other than in the particulars mentioned, the structure of Figures 4 and 5 may be understood to be substantially the same as the structure first described.

The embodiments of the invention described are subject to many variations and modifications within the contemplation of the invention, and within the scope of the following claims.

I claim:

1. For the support of an arched furnace roof of refractory blocks, a roof ring fabricated of a plurality of metal annuli comprising a vertical web, a horizontal web integrated with and extending radially inward from the vertical web; and an upwardly and outwardly divergent conical web that is welded at its upper edge to said vertical web and that is welded at its lower edge to said horizontal web on a circumferential line spaced from the inner edge of said horizontal web, and that forms a conical seat for the skewblocks of said roof, the three webs comprising the walls and floor of an annular cooling water chamber, with the water-cooled floor of said chamber

extended radially inward from the lower edge of the conical web in a flange portion that forms a water-cooled ledge for cooperation with said water-cooled conical seat in the support of said skew-blocks, and fluid conducting connections secured to said annular cooling water chamber for conducting cooling water through said chamber.

2. For the support of an arched furnace roof of refractory blocks, a roof ring comprising a vertical web, a horizontal web integrated with and extending radially inward from the vertical web; and an upwardly and outwardly divergent conical web that is welded at its upper edge to said vertical web, that is welded at its lower edge to said horizontal web on a circumferential line spaced from the inner edge of said horizontal web, and that forms a conical seat for the skew-blocks of said roof, the body of said horizontal web being provided with slots that extend through its inner edge towards said circumferential line, the three webs comprising the walls and floor of an annular cooling water chamber, with the water-cooled floor of said chamber extended in a slotted flange portion that forms a water-cooled ledge for cooperation with said water-cooled conical seat in the support of said skew-blocks, and fluid conducting connections secured to said annular cooling water chamber for conducting cooling water through said chamber.

3. For the support of an arched furnace roof of refractory blocks, a roof ring comprising three annuli of metal assembled and welded to form an annular chamber for cooling water, one annulus in the welded assembly being of upwardly and outwardly divergent conical shape and forming the inner side wall of said chamber and providing a water-cooled seat for the skew-blocks of said roof, the second annulus being welded to the upper edge of said conical annulus and extending downwardly from the weld to form the outer side wall of said chamber, and the third annulus comprising a substantially horizontal member forming the floor of said chamber and welded to said second annulus and to the lower edge of said first annulus, and extending inwardly beyond the lower edge of said first annulus to form a water-cooled ledge that cooperates with said seat in supporting said skew-blocks, and pipes secured to said annular cooling water chamber for passing cooling water through said chamber.

4. For the support of an arched furnace roof of refractory blocks, a roof ring comprising three annuli of metal assembled and welded to form an annular chamber for cooling water, one annulus in the welded assembly being of upwardly and outwardly divergent conical shape and forming the inner side wall of said chamber and providing a water-cooled seat for the skew-blocks of said roof, the second annulus being welded to the upper edge of said conical annulus and extending downwardly from the weld to form the outer side wall of said chamber, and the third annulus comprising a substantially horizontal member forming the floor of said chamber and welded to said second annulus and to the lower edge of said first annulus, and extending inwardly beyond the lower edge of said first annulus to form a water-cooled ledge that cooperates with said seat in supporting said skew-blocks, said ledge including in its circumferential extent a series of spaced slots that extend through the edge of the ledge towards said conical seat, and fluid conducting connections secured to said annular cooling water chamber for conducting cooling water through said chamber.

5. A roof structure for furnaces comprising a roof ring for supporting roof refractories, said ring having a vertical portion and an inwardly turned horizontal flange portion having its outer end welded to the lower end of said vertical portion, refractory-supporting means forming a skew-back, said means having an upper edge portion welded to the vertical portion of the ring and having a lower edge portion welded to the horizontal flange intermediate the width of the flange to form an annular cooling water chamber of triangular cross section and whereby a portion of said flange extends inwardly beyond the edge of said skew-back to provide a refractory supporting ledge that cooperates with the refractory-supporting means first mentioned, and refractory blocks abutted against the skew-back, said blocks having an undercut portion to receive the supporting ledge of the flange whereby the blocks overhang the ledge and are supported thereby, an annular refractory furnace wall directly supporting said refractory supporting ledge and said roof structure, and fluid conducting connections secured to said annular cooling water chamber for conducting cooling water through said chamber.

WILLIAM E. MOORE.