July 5, 1949. R. E. LONGACRE 2,475,102

REFRACTORY LINING FOR FURNACE DOORS

Filed Aug. 31, 1943 2 Sheets-Sheet 1

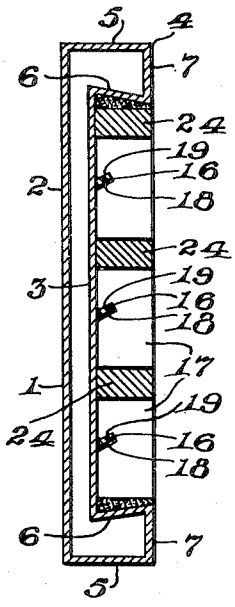

Fig. 2.

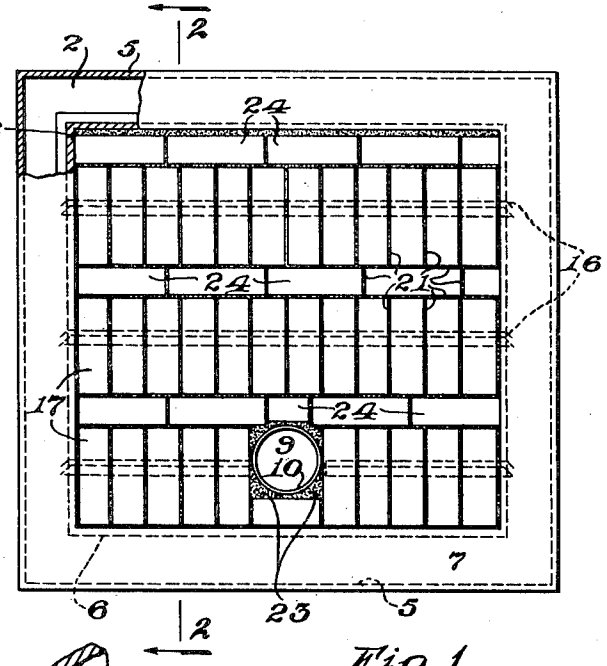

Fig. 1.

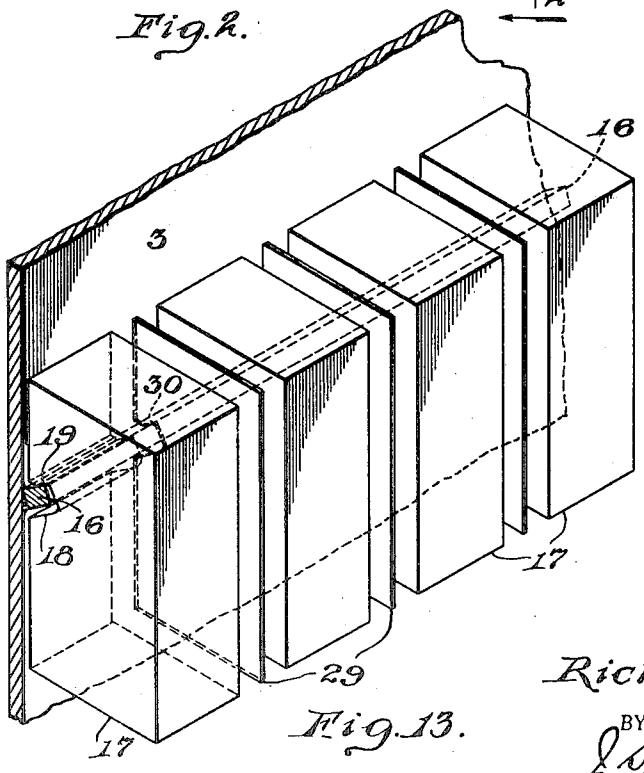

Fig. 13.

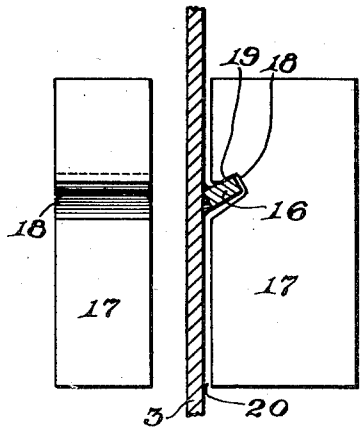

Fig. 10. Fig. 9.

INVENTOR,
Richard E. Longacre,
BY
J. Stuart Freeman,
ATTORNEY.

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REFRACTORY LINING FOR FURNACE DOORS

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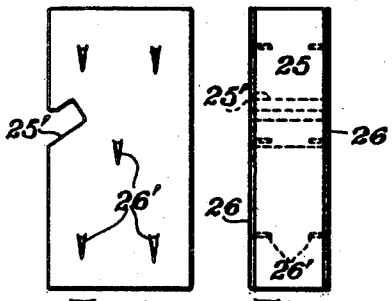

Fig. 3.

Fig. 4.

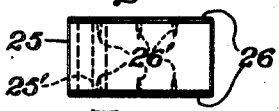

Fig. 5.

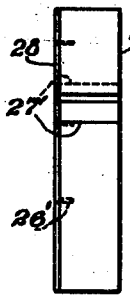

Fig. 7.

Fig. 6.

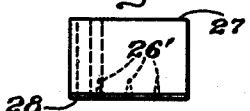

Fig. 8.

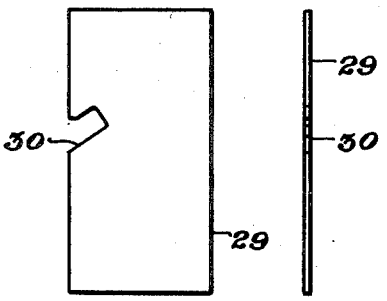

Fig. 11.

Fig. 12.

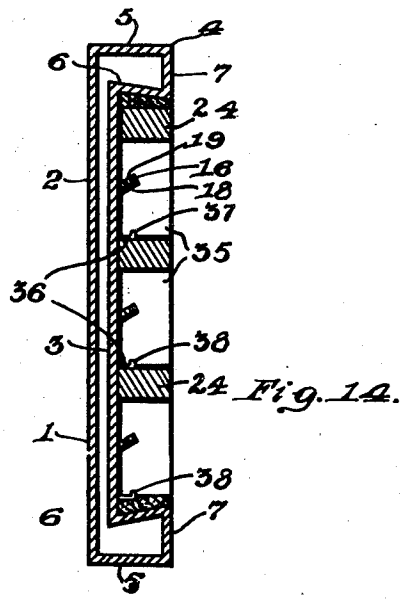

Fig. 14.

Inventor

Richard E. Longacre,

By J. Stuart Freeman,

Attorney

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REFRACTORY LINING FOR FURNACE DOORS

Richard E. Longacre, Wayne, Pa., assignor to General Refractories Company, Philadelphia, Pa., a corporation of Pennsylvania

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7 Claims. (Cl. 110—173)

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The object of the invention is to provide improvements in the methods of lining and the better protection of doors and other elements or sections of furnaces and the like, especially such are used in the melting or heat-treatment of metals and their ores. As the principles involved are applicable to many uses other than doors specifically, it is to be understood that use hereinafter of the term "door," or "doors," equally includes any other elements or sections of furnaces, kilns, soaking pits, etc., to which said principles may be applied, the term furnaces being employed to include all such last-mentioned devices.

These improvements as aforementioned can best be brought about by the use of a basic material (chrome, chrome-magnesite, magnesite or other high magnesia material of 28% or more), either in the form of a preformed brick with suitable anchoring, tieing or holding in operative position, or in the use of plastic, ramming or casting mixes of the above-mentioned basic materials suitably held in, as hereinafter described. The basic material in general, due to its chemical composition, has distinct advantages to the user, in that it offers a greater resistance to the cutting and wearing action of the splashed metal and slag. Attacking fluxes, combined with the high temperatures and other service factors in a furnace, cause severe punishment and resulting comparatively short life of the linings. Preformed basic brick has the additional advantage of being a molded, homogeneous structure, with a density that contributes increased resistance to the deteriorating influences mentioned.

The generally accepted practice in the past has been to use clay or silica brick for such linings, and the comparative short life of doors so lined has been accepted as an unavoidable evil. In recent years certain plastic chrome ore materials have been used to increase this life, but their successful use, due to the nature of that material, necessitates a system of heat conduction to the water-cooled surface of the door, due to the necessity of maintaining a cooler working or service face. This necessary cooling of the working or service face of the lining causes difficult to measure but unquestionable high heat losses from the furnace. The generally accepted practice for this cooling has been through bolts or rivets, attached to the inside metal shell of the water-cooled door and extending through the monolithic rammed mix to, or practically to, the service face of the material. The nature of the bolts or rivets, while they rapidly conduct heat, is such that they do not act as a good retaining or anchoring medium

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for the lining, with the result that doors so lined can rarely be repaired in certain isolated sections without removing the entire lining, or at least a major portion of it. Since the linings usually, by nature of their service, wear out and become thin in isolated sections (in many cases only from 20% to 30% or even less, of the lining requires frequent replacement), there is need for some medium of securing certain still serviceable sections or portions of these linings in place, while repairs are made to that portion or portions of the door where such repairs are necessary.

One object of this invention is to efficiently anchor a preformed basic brick to a door or other furnace element, and lay this brick up with a joint of material having basic chemical characteristics. This type of lining, in addition to its resistance to the fluxes, etc., as hereinbefore referred to, has the distinct advantage of not conducting heat to the water-cooled section of the door at anywhere near as rapid a rate as that of the existing method of using plastic chrome ores, wherefore, due to this lower heat conductivity, it effects a considerable fuel saving. Another distinct advantage is that anchoring of the brick in this type of structure permits the independent repairing or replacement of the section or sections of the door which are usually worn out more rapidly, while retaining still serviceable portions of the door in their approximate original condition, thus not necessitating the removal of still serviceable portions of the door at the time of every repair, as is at present the usual practice. The assembled cost of this type of construction is also less than that of doors rammed with plastic chrome ore.

There are certain operations in which the cooling of the working or service face of the lining is desirable, even at the expense of certain heat losses. In such cases, steel plates are interposed between adjacent surfaces of neighboring brick, which plates being a better conductor of heat than are the bricks, tend to lower the temperature of the working face of the door. Also the inner edges of said plates, exposed to the direct beat of the furnace, rapidly oxidize and in so doing expand in such manner as to form bulbous portions, which to a marked degree contribute to the mechanical anchoring of the brick in the composite door structure, while chemical action between the steel of the plates and the basic material of said brick also increase the aggregate degree of resultant unity.

Said basic brick and plate combination may be achieved by using individual bricks, between

which are positioned independent metallic plates, or by unitarily securing one or more metallic plates to the side or sides of the bricks either during or after their initial formation. In addition to the heat conductivity factor of this type of construction, the plates, attached or unattached, by means of the improved system of anchoring, act as a further stabilizing and anchoring influence in the structure, thus providing an improved and more effective means of supporting both the bricks and the steel plates in operative position with respect to the door or other furnace element. The use of basic brick unitarily plated, or with independent plates, in this type of construction, also has the same advantages of resistance to the deteriorating action of metal, slag, fluxes, etc., while permitting sectional or portional replacement, as described for the anchored brick laid with cement.

In the field of basic plastic mixes, plastic chrome ore as previously explained has been used as a door protection, as until recently it has been the best plastic material available. In recent months, however, there have been developed certain plastic mixes of high magnesia content (over 28% MgO), and this substantial content of magnesia, magnesium oxide, or similar magnesium compound, offers the distinct advantage over plastic chrome ore of being more resistant to the fluxing action of certain metals, slags, fluxes, etc., that are encountered by these linings. An object of this invention, therefore, is the use of these higher magnesia content plastic mixes, either in a monolithic lining or in a partitioned lining.

Another and more specific object is to provide improved means for conducting an appreciable degree of heat from the inner, or exposed, face of the door to its outer, or cooled, face, in the case of plastic ore mixes, having particularly in mind the desirability of being able to replace minor sections of the protective lining of such door or the like, without having to first remove and replace larger relatively undamaged portions, as has heretofore usually been necessary in the case of all monolithic linings.

With the objects thus set forth, the invention comprises further details of construction and operation, which are hereinafter fully brought out in the following description, when read in conjunction with the accompanying drawings, in which Fig. 1 is an elevational view of a door comprising individually supported basic bricks of chrome, chrome magnesite, magnesite (MgO 25% or over) bonded or grouted with a highly refractory cement and/or metal joint; Fig. 2 is a section on the line 2—2 of Fig. 1; Figs. 3, 4 and 5 are respectively side, edge and bottom plan views of a special brick, having a pair of heat-conducting plates upon and forming a unitary part of its laterally opposite surfaces; Figs. 6, 7 and 8 are respectively side, edge and bottom plan views of an alternative form of brick, having a single such plate forming a unitary part of but one of its lateral surfaces; Figs. 9 and 10 are respectively side and edge views of another alternative form of basic brick and no attached plates; Figs. 11 and 12 are respectively side and edge views of a single independent plate, such as can be operatively associated with bricks of the types shown in Figs. 9 and 10, for effecting a result equivalent to that obtained by using bricks of the types shown in Figs. 3–5 and 6–8; Fig. 13 is a fragmentary perspective view showing an intermediate step in the assembly of bricks and intervening plates on a furance door or other element; and Fig. 14 is a vertical sectional view showing an additional way in which the brick can be mounted within the door.

Referring to Figs. 1 and 2, a representative type of water-cooled door is represented as comprising a central planular section 1, composed of outer and inner spaced walls 2 and 3, said central section being surrounded by a peripherally extending marginal portion 4, composed of spaced outer and inner walls 5 and 6, which comprise integral extensions of the respective first-mentioned walls 2 and 3, and are themselves connected together at their inner edges by a marginal wall section 7, which defines the plane of the inner face of the door. Although the door illustrated is planular in shape, and has an inner face that is truly a plane surface, it is to be understood that the invention in its several forms is equally applicable to doors and the like of other design, as for instance those having inner curved surfaces, whether concave or convex, and in such cases whether cylindrical, spherical, or a combination of such shapes. As this is a standard type of door, no water or other fluid connections have been shown, since their location plays no part in the invention.

A vertical series of spaced bars 16 of rectangular or other suitable cross section is shown as being welded or otherwise secured to the inner surface of the wall 3 of the door, while upon these bars are hung rows of high grade refractory brick 17, such as are shown in detail in Figs. 9 and 10. Each of these brick is provided upon one side with a molded or sawed cutout 18, having a diagonally inwardly and upwardly extending upper surface 19, which rests directly upon the similarly sloping upper surface of one of said bars. However, the essential part of this construction is that the relation of the supporting bars to that portion of the bricks in contact therewith is such that the bricks, once placed thereon, tend to gravitate towards a position closely adjacent to if not in direct contact with the inner frontal wall 3. If the bricks do not actually contact said frontal wall, the narrow gap 20 may be filled with a continuation of the same cement that fills the slender spaces 21 between adjacent bricks. In the event of more or less irregular spaces 23 occurring around the wicket hole 9 and pipe 10, they may be similarly filled with bricks and cement, or with cement or plastic mix alone, in order to insure a completely homogeneous inner surface of the door.

The brick-supporting bars 16 may be positioned at any desired spacing, so that the bricks of adjacent rows substantially contact one another. However, in that case, in order to replace one or more bricks in a lower row, at least those immediately above them in the upper rows must be first removed and subsequently replaced. A better construction has been found to consist in arranging the said bars and resulting rows of bricks at such vertically spaced intervals, that intervening rows of transversely extending straights or tiles 24 (or cement) may be so interposed, that such a row serves in effect as a key to lock in position the horizontal row next below it, whereby in order to replace the bricks in such lower row one or more of said locking or key bricks must be first removed, after which the lower bricks or broken portions of the same may be removed without disturbing any of the bricks in the row or rows hung above it. This construction is shown in Fig. 1, and has proved to be most economical and efficient, especially when

using basic bricks, but can be still further improved economically for use under certain heat conditions, by further increasing the rate at which the heat at the inner surface of the brick is led towards the water-cooled surface of the door, and thereby increase the life of the brick.

Such increased economy is obtained in general by interposing steel plates between the lateral surfaces of adjacent bricks, or comprising unitary parts thereof. Referring to Figs. 3–5, the brick **25** there shown is similar to that shown in Figs. 9–10, except that to its laterally opposite surfaces are secured plates **26**, by means of inwardly directed lugs **26'**, which plates may be entirely separate and independent of each other, or may be connected at least across the rear edge surface of the interposed refractory, in order to thereby insure greater surface contact with the water-cooled wall **3**, the composite brick being provided with a cutout **25'** similar to the cutout **18** hereinbefore described. A brick more completely or entirely clad in steel may be employed, if desired, but it is unnecessary that two metallic plates be positioned between adjacent bricks. From this fact, it will be clearly apparent that a brick of the type shown in Figs. 6–8 will for all practical purposes be just as efficient in the conduction of heat, as though a double thickness of intervening metal were employed. This brick **27**, having a cutout **27'**, is the same as hereinbefore described, but has only a single plate **28** upon one lateral surface, with the result that each plate upon effecting a complete assembly contacts and separates the brick by which it is carried, and of which it forms a unitary part, from the brick next adjacent thereto.

Finally, as there are instances in which a furnace operator may have on hand numerous standard straight bricks of the regular unclad type, such as those shown in Figs. 9–10, he can saw or otherwise cut notches in them, merely insuring an inward and upward slope of the upper surface **19**, and assemble them upon the door or similar furnace element, as indicated in Fig. 13, and while so doing place between them metal plates **29** having similar cutouts **30**, such as is illustrated in detail in Figs. 11 and 12. Or plates of this type may be welded or otherwise secured to the cooled outer wall, instead of hanging them upon rods such as shown in Figs. 1, 2, 9 and 13. Such a longitudinal series of alternate bricks and plates is compressed together to form a solid, unitary mass, which is as effective as any of the other forms hereinbefore described, while under certain conditions permitting further economies as a result of its being possible to cut the metallic plates from scrap of permissibly different thicknesses when necessary, while the bricks used with them do not require the same special handling, as when they include one or more plates as a unitary part.

In Fig. 14 the same style of door is shown as in Fig. 2, and accordingly is similarly numeraled. Refractory brick **35** are shown as being supported by the bars **16**, exactly as hereinbefore described, but in addition thereto the bottoms of the brick in each course are likewise restrained against shifting or warping out from the plane of the inner face of the door by means of either continuous or spaced individual bars **36** having upwardly directed lugs **37** which enter recesses **38** in the under surfaces of said brick. Thus, the slanting bars **16** and the lower bars **36** cooperate to insure a unitary relationship between said brick and the adjacent wall of said door.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:

1. A furnace door, comprising a substantially flat central portion positioned in a substantially vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, alternately positioned bricks and metallic plates having upwardly sloping recesses into which said bar extends, as said bricks and said plates hang thereon and slide by gravity towards said face.

2. A furnace door, comprising a substantially flat central portion positioned in a substantially vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, alternately positioned bricks and metallic plates having upwardly sloping recesses into which said bar extends, as said bricks and said plates hang thereon and slide by gravity towards said face, the inward depth of the upper surface of the recesses in said bricks and said plates being greater than that of the upper surface of said bar.

3. A furnace door, comprising a substantially flat central portion positioned in a substantially vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, alternately positioned bricks and metallic plates having upwardly sloping recesses into which said bar extends, as said bricks and said plates hang thereon and slide by gravity towards said face, the inward depth of the upper surface of the recesses in said bricks and said plates being greater than that of the upper surface of said bar, said bricks and plates being supported by and removable from said bar independently of one another.

4. A furnace door, comprising a substantially flat central portion positioned in a substantially vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, alternately positioned bricks and metallic plates having upwardly sloping recesses into which said bar extends, as said bricks and said plates hang thereon and slide by gravity towards said face, the inward depth of the upper surface of the recesses in said bricks and said plates being greater than that of the upper surface of said bar, the central portion of the surrounding flange being hollow and provided with connections for circulating a cooling fluid through them.

5. A furnace door, comprising a substantially

flat central portion positioned in a substantially vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, alternately positioned bricks and metallic plates having upwardly sloping recesses into which said bar extends, as said bricks and said plates hang thereon and slide by gravity towards said face, the inward depth of the upper surface of the recesses in said bricks and said plates being greater than that of the upper surface of said bar, and said bricks and plates being supported by and removable from said bar independently of one another, the central portion of the surrounding flange being hollow and provided with connections for circulating a cooling fluid through them.

6. A furnace door, comprising a substantially flat central portion positioned in a normally vertical plane, and having a peripheral flange extending outwardly from one face thereof to define a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending transversely across said central portion, its upper surface being at an acute angle with said face, an upwardly directed L-shaped lug spaced beneath said bar and also secured to said flat central portion, and a plurality of bricks and intervening metallic plates having upwardly sloping recesses to receive said bar and gravitate thereon towards said face, and also having recesses in their lowermost portions to receive said lug, to prevent said lowermost portions from shifting from said surface.

7. A furnace door, comprising a substantially flat central portion positioned in a normally vertical plane, and having a peripheral flange extending outwardly from one face thereof to define

a recess, the inner wall of which is said face, a substantially horizontal bar extending between the opposite sides of said flange and having its longitudinal axis extending tranversely across said central portion, its upper surface being at an acute angle with said face, an upwardly directed L-shaped lug spaced beneath said bar and also secured to said flat central portion, and a plurality of bricks and intervening metallic plates having upwardly sloping recesses to receive said bar and gravitate thereon towards said face, and also having recesses in their lowermost portions to receive said lug, to prevent said lowermost portions from shifting from said surface, said brick and said plates being independently removable from and slidable laterally upon said bar and said lug.

RICHARD E. LONGACRE.

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