Feb. 22, 1949. W. F. ROCHOW 2,462,289

FURNACE REFRACTORY CONSTRUCTION

Filed June 11, 1945 3 Sheets-Sheet 1

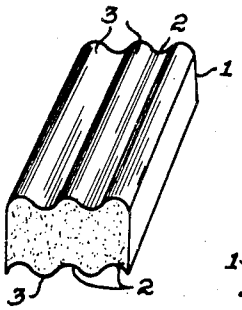

Fig. 1.

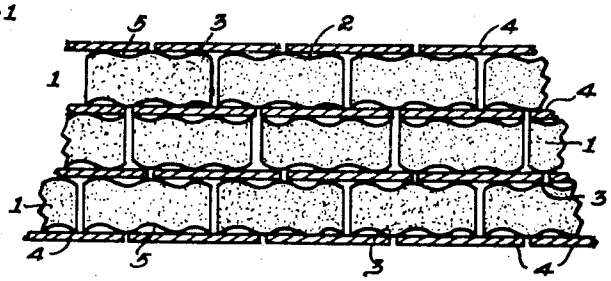

Fig. 2.

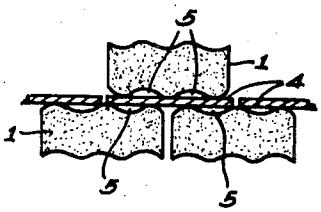

Fig. 3.

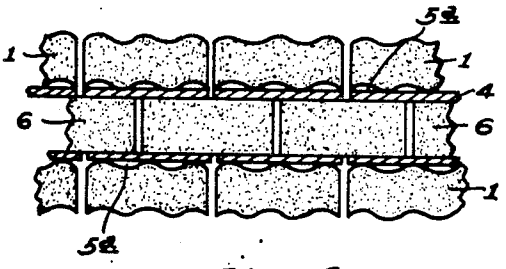

Fig. 4.

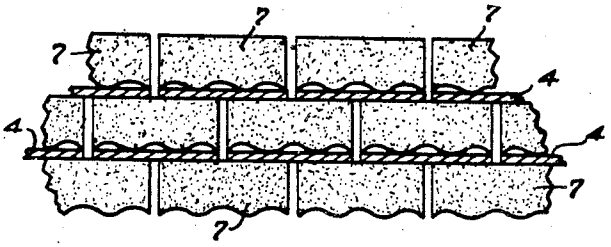

Fig. 5.

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FURNACE REFRACTORY CONSTRUCTION

Filed June 11, 1945 3 Sheets-Sheet 2

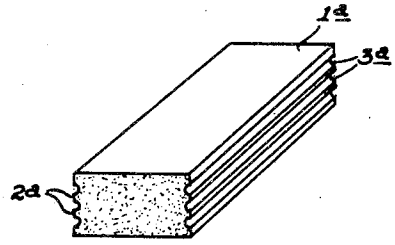

Fig. 6.

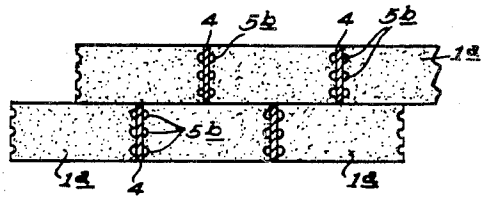

Fig. 8.

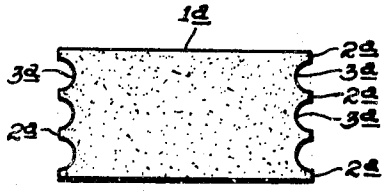

Fig. 7.

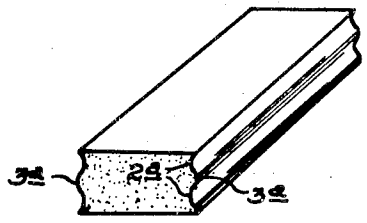

Fig. 9.

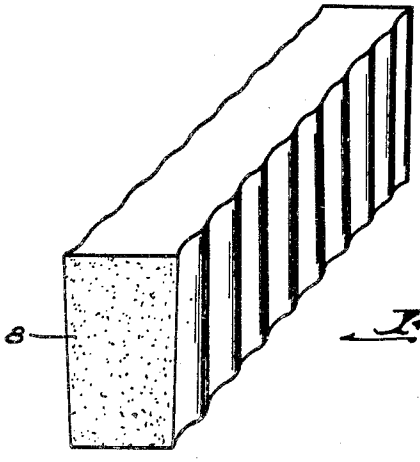

Fig. 10.

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FURNACE REFRACTORY CONSTRUCTION

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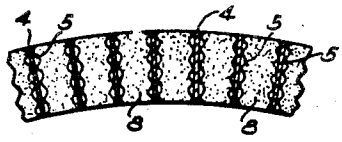

Fig. 11.

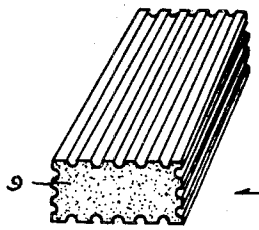

Fig. 12.

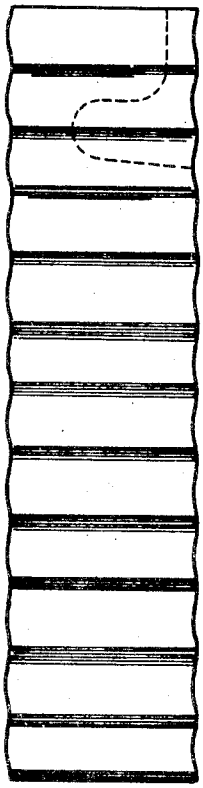

Fig. 13.

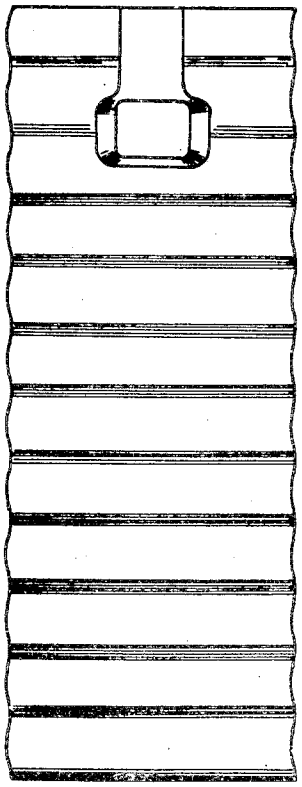

Fig. 14.

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UNITED STATES PATENT OFFICE

2,462,289

FURNACE REFRACTORY CONSTRUCTION

William F. Rochow, Pittsburgh, Pa., assignor to Harbison-Walker Refractories Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application June 11, 1945, Serial No. 598,774

11 Claims. (Cl. 72—37)

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This invention relates to furnace structures comprising sections built from non-acidic bricks, or shapes, integrated and rendered resistant to spalling by oxidation of metal interposed between adjacent brick faces in laying up the section.

Structures of this type have usually been made from metal cased refractories comprising a body of non-acidic refractory material and a mantle, sheath, or casing, of oxidizable metal wholly or partially covering the body. Magnesite, chrome ore, and chrome-magnesite batches have commonly been used for such purposes, although other non-acidic materials may be used also. More recently it has been found that metal casing is satisfactorily applicable also to forsterite, or magnesium orthosilicate, refractories, as disclosed and claimed in U. S. Patent No. 2,216,813 to V. M. Goldschmidt, and forsterite is accordingly to be considered a non-acidic refractory as the term is used hereinafter. Oxidizable ferrous metals, such as iron or plain carbon steel, have customarily been used as the casing metal of such composite refractories, but high temperature steels, such as the various chromium steels, can be used also. For brevity of reference in the following specification and claims all such materials are contemplated by the expression "ferrous metals."

When a furnace structure built from metal cased refractories is heated, for example in the use of the furnace, the ferrous metal casing is oxidized with production of iron oxide. The oxide readily penetrates non-acidic refractories and it acts to bond, or integrate, the bricks, or other shapes, into a more or less monolithic structure. As a result of this, spalling from the brick surfaces is reduced to a considerable extent, as is well recognized in the art. For this reason metal cased refractories have been used extensively, for example in metallurgical furnaces including, for instance, the construction of exposed walls and suspended roofs of copper reverberatory and refining furnaces, exposed walls of open hearth and electric steel furnaces, and in other built-up furnace sections such as back and front walls, the ends, bulkheads, division walls, uptakes and bridge walls, as well as for open hearth roofs, rotary kiln linings, and other furnace sections where renewal of ordinary refractory shapes is frequently necessary as a result of spalling.

Metal cased refractory structures have been made in various ways. For instance, iron plates have been inserted between ordinary refractory shapes in the construction of furnace sections, as disclosed in Patent No. 1,123,874 to J. Hemmer.

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The first true metal cased refractories, that is, comprising a refractory body enclosed wholly or partially by a metal casing, were made in accordance with Patent No. 1,106,725 to N. E. Maccallum by packing non-acidic refractory material in a thin-walled ferrous metal tube. Those refractory shapes effected substantial reduction in spalling and were used extensively. However, they suffered from the disadvantage that in consequence of their method of production the density of the refractory body was not as high as could be desired.

More recently metal casing has been applied to preformed refractory shapes, as illustrated by Patent No. 1,672,524 to H. B. Groniger, and U. S. Patent No. 2,289,911 to R. P. Heuer. According to the Groniger patent refractory shapes are made from non-acidic material in the customary way and the shapes are then inserted in a correspondingly shaped ferrous metal casing. According to the Heuer patent there is placed in a mold a casing having projections adapted to interlock with the refractory body, and a batch of non-acidic material is pressed in the mold to embed the projections in it and thus form the metal cased article in the pressing operation.

Metal casing, or metal jointing as it may also be called, has been subject to various disadvantages inherent in all of the previous practices known to me, such as those described briefly hereinabove, which have continued down to the time of the present invention despite their recognition and the extensive use of the various forms of metal casing. Chief among these is the fact that in all of the previous practices of which I have knowledge the casings conformed to and closely fitted the contour of the faces of the bricks, or other shapes, and especially has that been true of metal cased refractories made by packing the refractory batch in tubular casings or by pressing it with the casing in the mold. The formation of iron oxide from iron involves an increase in volume; more iron is provided than is necessary for bonding; and all of the iron oxide produced is not absorbed into the brick faces. As a result growth due to the formation of unabsorbed iron oxide may occur and set up compression stresses that tend to cause shearing, buckling, or other undesired effects.

Another disadvantage of some types of prior metal cased refractories has been the necessity for producing the composite refractory articles at the brick plant, thus necessitating transportation of the casing material to the brick plant and

its reshipment to the point of use, which is undesirable for reasons of economy.

A primary object of the present invention is to provide integrated furnace structures of the foregoing type which are free from the aforementioned disadvantages.

A further object is to provide furnace structures built up from non-acidic refractory shapes and oxidizable metal as simply, easily, and inexpensively as those known prior to this invention, which provide effective bonding by oxidation of the metal, and in which adequate provision is made for growth due to metal oxide formation without the creation of detrimental compression stresses.

Still another object is to provide a method of building furnace sections in accordance with the foregoing objects.

Other objects will be recognized from the following specification.

The invention will be described with reference to the accompanying drawings in which Fig. 1 is a perspective view of a 9-inch straight brick shape used in the practice of this invention; Fig. 2 a fragmentary vertical elevation of several courses of a furnace section constructed in accordance with this invention from the shape shown in Fig. 1; Fig. 3 a fragmentary view similar to Fig. 2 illustrating a modified mode of laying up the shape shown in Fig. 1; Figs. 4 and 5 views similar to Fig. 2 illustrating two of the various permissible modifications; Figs. 6 and 7 perspective and end views, respectively, of a modified form of 9-inch straight that may be used in practicing the invention; Fig. 8 a view similar to Fig. 2 showing the use of the shape of Figs. 6 and 7; Fig. 9 a perspective view of yet another form of shape that may be used; Fig. 10 a perspective view of an arch brick for use in practicing the invention; Fig. 11 a fragmentary cross sectional view through a rotary kiln lining constructed from the shape shown in Fig. 10; Fig. 12 a perspective view of yet another modified form of shape for practicing the invention; and Figs. 13 and 14 side and front elevational views, respectively, of one form of shape for use in practicing the invention for the construction of suspended roofs.

In accordance with the present invention the furnace section is laid up from preformed non-acidic refractory bricks, or shapes, having at least one face provided with recessed portions. Such bricks are laid up with those faces constituting at least one of the faces of a pair of opposed faces, and a flat surfaced oxidizable metal plate is disposed between the said opposed faces to contact only the projecting portions which extend forwardly from the recesses. Most suitably the recesses are formed by providing the said opposed faces with spaced parallel rib members so that the flat metal plates contact only the rib portions. In this way the function of metal casing is provided but in addition the disadvantages mentioned hereinabove are avoided because the recesses, such as the grooves between the ribs, afford space for reception of excess metallic oxide formed and thus the troubles previously encountered as a result of oxide growth are eliminated. Moreover, the metal elements may be shipped directly from the plant where they are produced to the point of erection, with attendant economy.

In the preferred embodiment at least two opposed faces of the shapes are provided with recessed portions, as by providing them with ribs.

The brick shapes are made according to any

desired practice, preferably from magnesite, chrome ore, chrome-magnesite, or forsterite, batches, although other non-acidic refractory materials may be used. Most suitably iron or plain carbon steel is used as the oxidizable metal. The shapes may be fired before being laid up or, and in accordance with common practice today, they may be pressed from batches containing a temporary binder and laid up in the unfired condition, to be fired after the furnace has been erected.

Having reference now to the drawings, Figs. 1 and 2 show an ordinary 9-inch refractory straight 1 having its major faces provided with longitudinal grooves 2 formed between longitudinal rib members 3. The bricks are laid up in courses in any desired fashion so that the grooves 2 and ribs 3 of each brick are substantially opposed to and aligned with the grooves and ribs, respectively, of the bricks on each side, as shown in Fig. 2. As the bricks are laid up, thin, flat surfaced plates 4, preferably of iron or plain carbon steel, are interposed between adjacent grooved faces, as seen in Fig. 2.

By the use of the flat surfaced casing elements 4, grooves 2 form therewith open areas 5, Fig. 2, into which excess iron oxide is free to grow. At the same time, the plates are in contact with ribs 3 so that provision is made for ready and adequate diffusion of iron oxide into the bricks 1, to bond them and render the structure resistant to spalling. This action will take place likewise in the grooved portions 2 as they become occupied by oxide. In this way the excess oxide grows freely into spaces 5 and consequently does not set up compression stresses.

Although it is preferred to use metal plates corresponding in area to the brick faces between which they are interposed, as indicated in Fig. 2, other forms of metallic elements may be used, as will be understood by those skilled in the art.

The spaces characteristic of this invention may be provided in other ways than shown in Figs. 1 and 2. For example, in Fig. 2 spaces 5 are opposed in consequence of laying the bricks 1 with the ribs 3 and grooves 2 of adjacent pairs of bricks opposite one another. In the embodiment of Fig. 3, however, the ribs of bricks 1, which are like that of Fig. 1, are laid so that the ribs and grooves of one brick of an adjacent pair are aligned with and opposed respectively to the grooves and ribs of the other adjacent brick, so that the spaces 5 will be staggered, as shown.

The gist of the invention resides, as will be understood from what has been said, in providing spaces into which the oxide of the casing, or jointing, metal may grow. To this end the faces of both of the shapes on opposite sides of the metal plate need not be recessed; i. e., it suffices for some purposes to have only one such face recessed. For example, this may be done as shown in Figs. 4 and 5. In Fig. 4 there are courses of bricks 1, like that of Fig. 1, with intermediate courses of ordinary, plane surfaced non-acidic bricks 6, so that the interposed flat plates, or sheets, 4 of ferrous or other oxidizable metal form recesses, or spaces, 5*a* for reception of oxide formed when members 4 oxidize. Or, this may be accomplished by shapes 7, Fig. 5, having one recessed face and an opposed plane surfaced face, the shapes being laid up with metal plates as shown in Fig. 5.

For ease of pressing the shapes it is preferred to recess the major faces. However, other forms are permissible. Thus, the side faces of the 9-inch

straight brick 1*a* shown in Figs. 6 and 7 are corrugated to provide grooves 3*a* and ribs 2*a*. It will be immediately evident from a consideration of Figs. 6 and 7 that such a brick will function in the same manner as that of Fig. 1 when laid up in accordance with the invention, and such a structure is shown in Fig. 8, the bricks 1*a* being laid up with interposed oxidizable metal plates 4 to form spaces 5*b*.

The invention is applicable generally to refractory shapes of the various kinds used for purposes where metal casing is desirable. For example, Fig. 10 represents an arch, or key, brick 8 provided along its side faces with corrugations similar to and serving the same function as those shown in the preceding figures. These are laid up in the manner described above, as seen in Fig. 11, which shows bricks 8 disposed so that the rib and groove portions of each brick are opposed to and aligned with those of the immediately adjacent bricks, and with plane surfaced iron or steel plate members 4 disposed therebetween to form spaces 5 with the corrugated recesses.

Although the invention has been illustrated and described thus far with respect to providing the recessed portions on the top or the side faces of the bricks, it will be understood that it is not limited thereto. Thus, both the major and the side faces of an ordinary straight 9 are shown in Fig. 12 as being provided with parallel ribs and grooves extending longitudinally thereof. And such recessed portions may extend transversely rather than longitudinally of the shapes.

Various other modifications are, of course, permissible without departing from the essence of the invention. Thus, the tongue and groove portions, or other recessed portions, may be formed otherwise than as shown in the drawings. Likewise the invention may be applied to other refractory shapes than straights and arch, or key, bricks, as well as to the various shapes that are used for the construction of suspended arches, and the like. By way of example, the recesses of the shapes of Figs. 1, 3 to 5 and 10 may be formed as shown in Figs. 6 and 7. Likewise, those of Figs. 6 and 7 may be formed as shown in Fig. 9. Again, Figs. 13 and 14 show the invention as applied to a conventional form of shape for constructing suspended furnace roofs; in this instance all four sides of the bricks are provided with corrugations. Other modifications will be realized by those familiar with the art.

According to the provisions of the patent statutes, I have explained the principle, mode of constructing, and mode of operation of my invention, and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A furnace structure including a section comprising preformed shapes of non-acidic refractory material and flat surfaced oxidizable metal plates disposed between adjacent pairs of faces of said shapes, and at least one of said faces of said pairs being provided with recessed portions providing spaces into which oxide of said metal may grow as the metal oxidizes in use of the furnace.

2. A structure according to claim 1, said plates being of oxidizable ferrous metal.

3. A furnace structure including a section comprising preformed shapes of non-acidic refractory material having at least two opposed faces provided with recessed portions, said shapes being laid with said recessed faces contiguous, and flat surfaced oxidizable ferrous metal plates disposed between adjacent pairs of said faces.

4. A furnace structure including a section laid up from preformed shapes of non-acidic refractory material having at least two opposed faces provided with substantially parallel spaced rib members, said shapes being laid with the ribs of a shape substantially opposed to and in alignment with those of the immediately adjacent shape, and flat surfaced oxidizable metal plates disposed between said faces and contacting only said rib members.

5. A furnace structure including a section laid up from preformed shapes of non-acidic refractory material having at least two opposed faces provided with substantially parallel spaced rib members, said shapes being laid with the ribs of the shape substantially opposed to and in alignment with the spaces between the ribs of the immediately adjacent shapes, and flat surfaced oxidizable ferrous metal plates disposed between said faces and contacting only said rib portions.

6. That method of constructing furnace sections which comprises providing preformed shapes of non-acidic material having at least one face provided with recessed portions, laying up the section from said shapes with at least one such face of the shapes constituting one of two opposed faces of adjacent shapes, and interposing between said opposed faces a flat surfaced oxidizable metal plate.

7. That method of constructing furnace sections which comprises providing preformed shapes of non-acidic material having at least two opposed faces provided with recessed portions, laying up the section from said shapes with said faces of the shapes contiguous, and interposing between said faces a flat surfaced oxidizable metal plate.

8. That method of constructing furnace sections which comprises providing preformed shapes of non-acidic material having at least two opposed faces provided with recessed portions, laying up the section from said shapes with said faces contiguous to those of the immediately adjacent shapes, interposing between said faces a flat surfaced oxidizable ferrous metal plate, and heating the finished section to oxidize said plates and integrate the structure.

9. That method of constructing furnace sections which comprises providing preformed shapes of non-acidic material having at least two opposed faces provided with substantially parallel spaced rib members, laying up the section from said shapes with said ribs of one shape substantially opposed to and in alignment with those of the immediately adjacent shapes, and interposing between said faces a flat surfaced oxidizable ferrous metal plate to contact only said rib members.

10. That method of constructing furnace sections which comprises providing preformed shapes of non-acidic material having at least two opposed faces provided with substantially parallel spaced rib members, laying up the section from said shapes with said ribs of one shape substantially opposed to and in alignment with the spaces between the ribs of the immediately adjacent shapes, and interposing between said faces a flat surfaced oxidizable ferrous metal plate to contact only said rib members.

11. An integrated furnace section comprising

shapes of non-acidic refractory material having at least one face provided with recessed portions and the shapes being disposed with said face constituting at least one of opposed faces of adjacent pairs of shapes, and portions of said opposed faces exposed to the heat of the furnace having absorbed therein integrating oxidation product of flat surfaced oxidizable metal plates disposed between said faces.

WILLIAM F. ROCHOW.

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