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REFRACTORY WALL SECTION AND METHOD OF MAKING THE SAME

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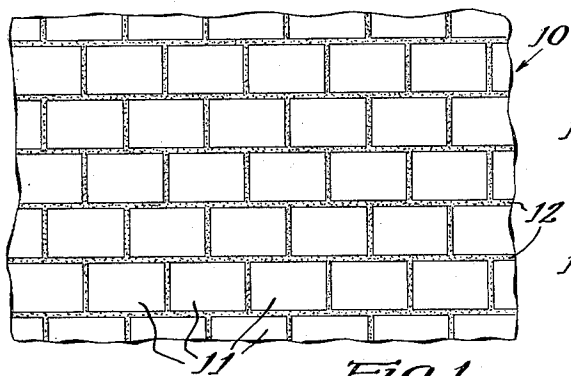


Fig. 1.

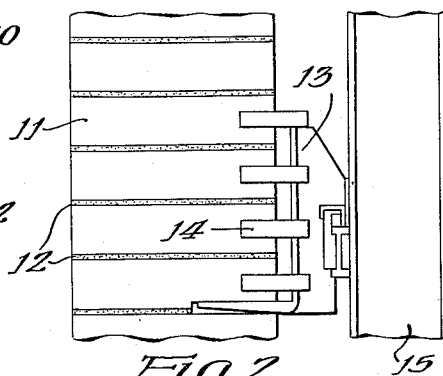


Fig. 2.

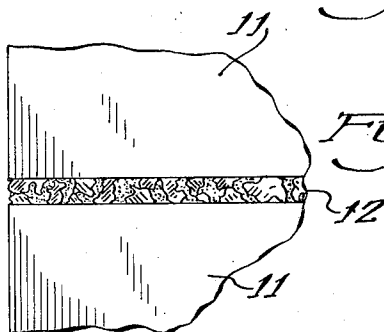


Fig. 3.

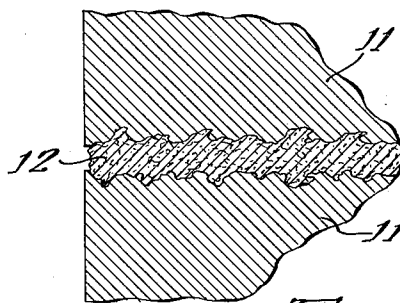


Fig. 4.

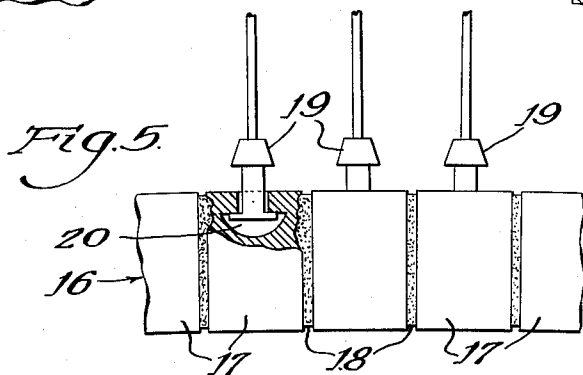


Fig. 5.

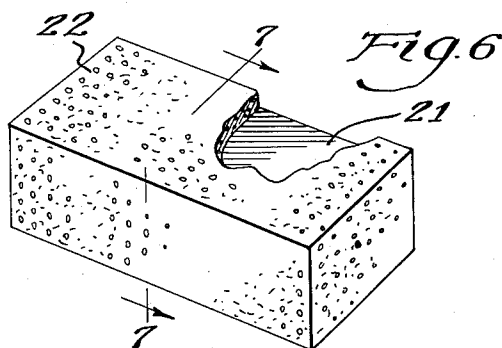
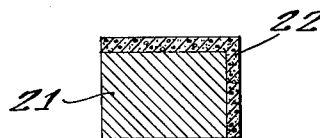


Fig. 6.

Fig. 7.



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REFRACTORY WALL SECTION AND METHOD OF MAKING THE SAME

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6 Claims. (Cl. 72—37)

This invention relates to an improved refractory wall section and to a method of making the same.

In the construction of certain types of refractory wall sections for use in furnaces and the like, it has been the practice to place a sheet of iron or steel in the joint between adjacent blocks. Then, as the furnace is used, the iron spacers oxidize, particularly at the exposed part of the joint, and the resulting iron oxide forms a bond between adjacent blocks which prevents hot gases from circulating into or through the joint. This bond reduces spalling and increases the life of the wall section.

The effectiveness of this method of construction is based on the fact that as the iron is converted from the metallic to the oxide state, it grows or expands in volume, thereby filling the joint. However, this growth continues even after a satisfactory bond has been attained thereby setting up a compressive stress which will shift the position of the blocks and which also in itself is a cause of fracture and spalling. Furthermore, since the metal spacer in itself forms no bond initially, and since the effectiveness of the bond that is formed is a function of time and of temperature, based on the extent of oxidation, it will be seen that there will inevitably be a certain amount of spalling immediately after installation and before the required degree of oxidation has taken place.

It is an object of this invention to provide an improved method for constructing a refractory wall section which overcomes the above-mentioned disadvantages; and, in particular, to provide a method which is not dependent upon the expansion of the joint material to provide a proper bond, thereby producing a wall section which is substantially free from the compressive stress above-mentioned.

It is a further object of this invention to provide a refractory wall section in which the joints between adjacent refractory blocks are filled with a porous metallic substance whereof the voids serve to provide space for the growth which accompanies the conversion of the metallic substance from its metallic state to its oxide state.

It is another object to provide a substantially monolithic basic refractory structure, suitable for use as a wall section, roof section, or the like, which is substantially free from compressive stresses and which is made up from a plurality of separate blocks or building units in which the joints are effectively bonded.

Still another object is to provide an improved wall section formed from basic refractory material which is characterized by its comparatively long life and low cost.

Other objects, features and advantages will become apparent as the description proceeds.

With reference now to the drawings in which like reference numerals designate like parts:

Fig. 1 is an elevation of a wall section illustrating one form of the invention;

Fig. 2 is a end view of Fig. 1;

Fig. 3 is an enlarged diagrammatic representation showing one of the joints of the wall section shown in Figs. 1 and 2, just after installation and after ignition;

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Fig. 4 is a view similar to Fig. 3, but showing the parts after the furnace has been in use for a considerable length of time;

Fig. 5 is a cross section of a roof structure, showing the application of this invention thereto;

Fig. 6 is an isometric view of a block illustrating a modified form of this invention, and

Fig. 7 is a cross section of the block.

In Figs. 1 and 2 the reference numeral 10 designates a wall section generally which is composed of a series of separate blocks 11, or other building units in combination with joint material 12 which in this instance may be applied in the form of a mortar. As shown in Fig. 2, the blocks may be individually supported by means of hangers 13 which engage the blocks in recesses 14. The hangers are mounted upon a suitable supporting structure 15.

The blocks 11 are preferably of a basic refractory material such as an unburned magnesium or chromic oxide, or a mixture of the two. These materials are commonly used in the manufacture of basic refractory blocks, bricks, or other building units.

The mortar material is a Thermit-type of material which in this instance can be applied or troweled onto the joint surfaces in the form of a mortar.

I have found that in bonding refractory blocks, that an improved bond may be formed by using a Thermit-type of material as a mortar material. After the blocks have been laid and the wall structure has been completed, the mortar material may be ignited by a welding torch or other means at any point in order to set off the reaction, or it may be ignited at elevated temperature from the heat of the furnace. The reaction products, an aluminum or magnesium oxide plus a reduced metal, such as iron, provides a very satisfactory bond, and one which will not grow or expand in such a manner as to set up an excessive compressive stress in the wall structure.

Where the refractory blocks are formed of a mixture of magnesium and chromic oxides which are compacted under extremely high pressure, either with or without a suitable bonding agent, I prefer to use a Thermit-type material which consists of a mixture of powdered aluminum and iron oxide in the form of mill scale. In addition, I prefer to include in the mixture a certain amount of metallic iron, preferably in the form of iron shot, of a diameter of approximately $\frac{1}{32}$ inch. The iron shot serves to give body to the mixture during the reaction so that it will not run out of the joint during the reaction, and which also serves to provide a mixture which initially has a number of voids therein, which voids are present in a certain degree in the reaction product, thereby providing a porous or spongy mass of material as diagrammatically illustrated in Fig. 3. The iron shot absorbs a considerable amount of the heat of the reaction so as to result in a somewhat viscous material at the reaction temperature which is non-homogeneous in character.

Assuming that a stoichiometric mixture of powdered aluminum and mill scale is employed, the proper amount of metallic iron in shot or other granular form to be added to the original mixture can readily be determined by experiment. If there is any substantial flow of the joint material out of the joints, the proportion of iron shot can be increased; if it is observed that the reaction is not self-sustaining, then the proportions of iron shot should be decreased.

An example of a satisfactory mixture is the following:

	Pounds
Aluminum powder	59.3
Mill scale	191.0
Barium peroxide	2.5
Iron shot	75.0

The aluminum, mill scale and iron shot are mixed in

a mortar box. The barium peroxide is added gradually to the mixed ingredients by "salting" or sprinkling it into the mix. The mixing should be thorough. To this dry mixture there is added 15.5 pints of sodium silicate solution and all of the ingredients thoroughly mixed.

There is then added a sufficient amount of ½% water solution of sodium carboxymethylcellulose to bring the mixture up to the desired troweling consistency. For instance 15 pints of such solution may be required.

The Thermit reaction is most vigorous when the ratio of aluminum to mill scale is in stoichiometric proportions; the amount of each of these materials, however, may vary as much as ten per cent or more from the stoichiometric amount and still produce usable joint materials. In general, the more massive the wall section in which the joint material is used, the closer the amounts of aluminum and mill scale should be to the stoichiometric ratio. For smaller sections, the amount of aluminum may be decreased.

The amount of metallic iron added can vary up to substantially 40 per cent. The amount of barium peroxide can vary up to five per cent or even more.

The metallic iron added to the mix need not be in the form of shot. Any shape of iron particles, whether in flakes, granular, turnings, etc., would be satisfactory. Iron shot is preferred due to its convenience. Similarly, mill scale is specified in the above example due to its convenience, but any form of iron oxide is suitable.

The oxides of iron are satisfactory for use in place of metallic iron. When they are used in place of metallic iron, however, the reacted joint material contains less metallic iron.

The use of sodium silicate and the organic solution are not necessary, either singly or in combination, when "making up" the mortar. The Thermit reaction is in no way dependent upon these materials. Plain water could be used; the mortar, however, would have poor workability. Other plasticizers such as clay, bentonite, gums, etc., would be satisfactory.

Magnesium powder would work satisfactorily in place of aluminum powder. If magnesium were used, the mix would require about 90 per cent as much as the amount of aluminum used. Other materials which might be used would be iron-aluminum or iron-magnesium intermetallic compounds, high in aluminum or magnesium, or metals such as calcium, beryllium, strontium, barium, or other metals whose oxides have high heats of formation compared to the heats of formation of the oxides of iron.

Similarly, metallic oxides other than iron oxide can be used, provided that the heats of formation of the oxides of such metal are less than the heats of formation of the oxides of the metal component of the Thermit-type of material.

The mortar may be applied to the joint surfaces of the blocks 11 as the blocks are laid. The thickness of the layer of mortar material is preferably about ¼ inch. After the wall has been laid, the wall section is preferably heated so that the temperature of the face of the blocks is increased from room temperature up to 900° F. over a period of about 22 hours. This permits the joint material to become thoroughly dry. Then the reaction can be started by igniting the mortar material at any desired point, preferably near the bottom of the panel.

After the reaction has been completed the furnace is ready for use. As shown in Fig. 3, at this time the joint is completely closed and it will be found that the reaction product is securely bonded to the refractory material. After the furnace has been used for a period of a day or two, it will be found that a considerable portion of the metallic iron, at a point near the exposed part of the joint, has been oxidized and that the voids which were originally present are not as large or as numerous. Furthermore, it will be found that some of the iron oxide has migrated into and penetrated beneath the surface of the blocks 10, and in some instances will

be chemically combined with the magnesium and chromic oxides to form an even more secure bond.

As shown in Fig. 5, the invention may be applied to a suspended roof, a roof section being generally designed by the reference numeral 16. It is formed from a plurality of blocks 17 which are joined together by a joint material 18 of similar compositions to that previously described. The blocks are individually suspended by means of hangers 19 which interlock in recesses 20.

A further modification of the invention is shown in Figs. 6 and 7 in which a block 21 has had applied to it at the time of fabrication a coating 22 of a mortar material previously described. These blocks 21 may be formed of a basic refractory as pointed out in connection with blocks 11 and may be of standard dimensions to provide a brick which may be laid up without any mortar, since the coating 22 takes the place of the mortar. As shown, the coating 22 is applied to three sides of the brick, although it may be applied to all six sides, if desired, or to any lesser number.

The blocks 21 may also be formed with recesses if desired in order that each block may be individually suspended; conversely the blocks 11 may be laid up into a wall without the use of hangers 13 and supporting means 15 in cases where their use is not required.

The term "wall section" as herein used is not limited to a side wall or to a roof, but refers generally to any portion of a structure which provides a refractory surface which is exposed to the heat of a furnace or the like.

The term "Thermit-type materials" as herein used refers not only to the mixture of aluminum powder and ferric oxide which is specifically referred to herein, but also to other mixtures of metals and oxides which produce exothermic reactions of a similar type.

It has been found that the structure produced by the practice of the present invention is substantially monolithic even immediately after the reaction, since the fusing and sintering accomplished by the heat of reaction extends throughout the whole joint, and is not confined only to the exposed portion thereof.

I claim:

1. A wall section comprising in combination two basic refractory blocks disposed adjacent to each other and joint material disposed between said blocks and bonding the joint surfaces thereof to each other, said joint material comprising the reaction product of a Thermit-type of material, and said Thermit-type of material comprising a mixture of a first metal and an oxide of iron, the heat of formation of the oxide of said first metal being greater than the heat of formation of the said oxide of iron, said mixture being characterized by an exothermic reaction, upon ignition, which is violent and self-sustaining, and said reaction product initially being in the form of a fused porous mass containing a substantial quantity of metallic iron.

2. A wall section according to claim 1 in which said Thermit-type of material also includes metallic iron in the form of granules which cooperate with each other and with the other ingredients of said Thermit-type of material so as to form voids, whereby said reaction product will be porous.

3. A wall structure comprising in combination two basic refractory blocks disposed adjacent to each other and a joint material disposed between said blocks and bonding the joint surfaces thereof to each other, said joint material comprising the reaction product of a Thermit-type of material, and being characterized by a porosity sufficient to absorb compressive stresses set up by the subsequent oxidation of said reaction product, and said Thermit-type of material comprising a mixture of a powdered metal, selected from the group consisting of aluminum and magnesium, and an oxide of iron, said mixture being characterized by an exothermic reaction, upon ignition, which is violent and self-sustaining, and

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said reaction product initially being in the form of a fused porous mass containing a substantial quantity of metallic iron.

4. The method of forming a wall section comprising the steps of laying up basic refractory blocks with a Thermit-type of mortar material between the adjacent surfaces thereof to provide a wall section, said Thermit-type of mortar material comprising a mixture of a first metal and an oxide of iron, the heat of formation of the oxide of said first metal being greater than the heat of formation of the said oxide of iron, said mixture being characterized by an exothermic reaction, upon ignition, which is violent and self-sustaining, and igniting said mortar material to cause the same to undergo a self-sustaining exothermic reaction whereby the heat of reaction causes a fusing of said mortar material which, upon hardening, forms a joint material which contains metallic iron and which bonds said blocks together.

5. The method of claim 4 which includes the additional step of heating said basic refractory blocks and said mortar material up to a temperature of not more than substantially 900° F. prior to igniting said mortar material.

6. The method claimed in claim 4 which includes the additional step of exposing the surface of said wall sec-

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tion to an elevated temperature and an oxidizing atmosphere after ignition of said mortar material whereby the metallic iron component of the reaction product of said Thermit-type of material will become oxidized and penetrate the surface of said blocks.

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