July 30, 1935. P. M. GINDER 2,009,547

METALLURGICAL FURNACE

Filed June 25, 1931

Fig. 3,

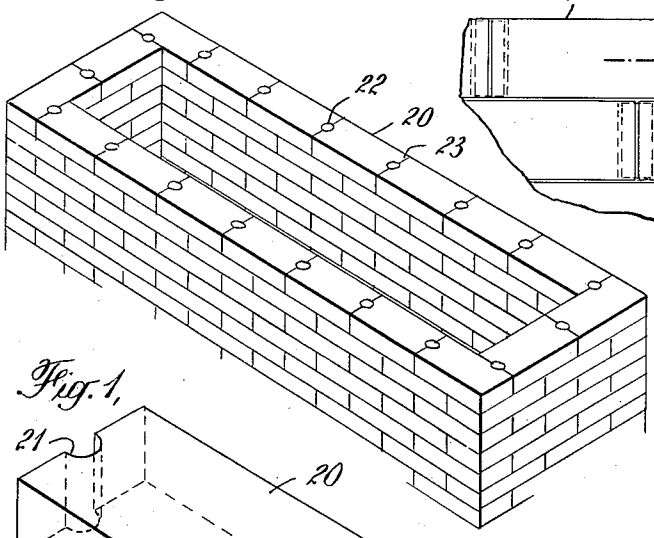


Fig. 4,

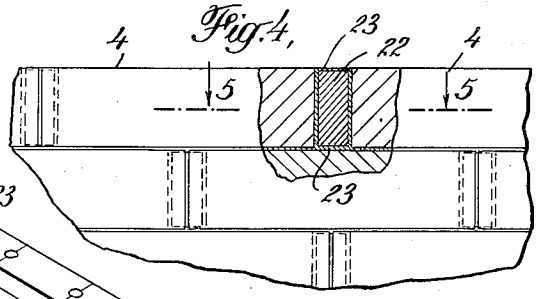


Fig. 5,

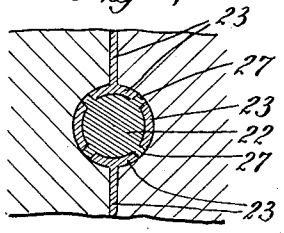


Fig. 1,

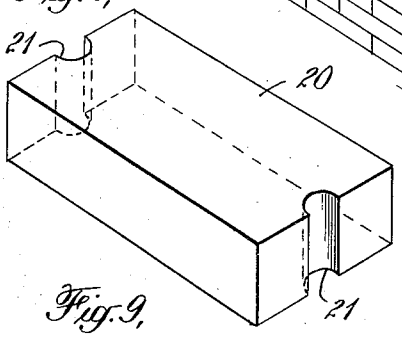


Fig. 6,

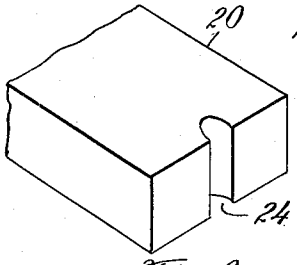


Fig. 2,

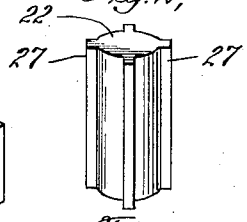


Fig. 9,

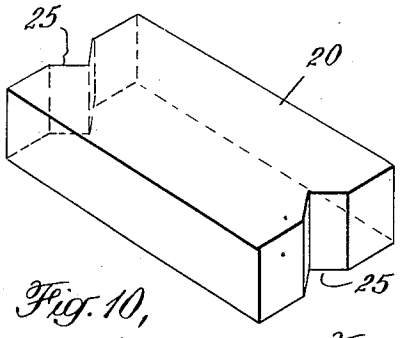


Fig. 7,

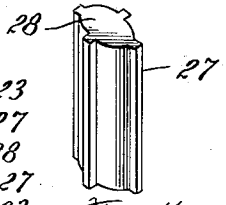


Fig. 8,

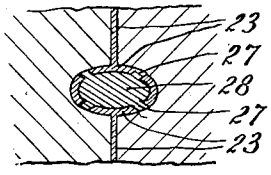


Fig. 10,

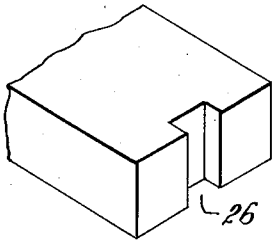


Fig. 12,

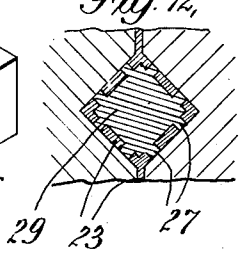


Fig. 13,

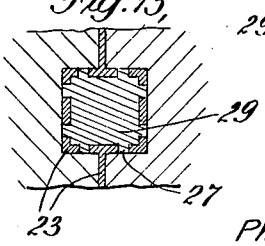
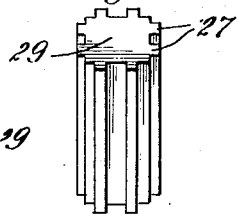


Fig. 11,



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METALLURGICAL FURNACE

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Application June 25, 1931, Serial No. 546,821

7 Claims. (Cl. 72—107)

This invention relates to metallurgical furnaces and has for its object certain improvements in metallurgical furnaces. The invention relates more particularly to improvements in the method of constructing a zinc metallurgical furnace, as well as to the zinc metallurgical furnace itself. In its more specific application, the invention relates to improvements in reduction retorts employed in zinc metallurgical furnaces.

In the operation of vertical zinc retorts constructed of refractory masonry, it has been found that the points at which such retorts first fail, that is the weakest parts of their construction, are the vertical joints between individual bricks. In the case of the horizontal joints, the pressure of the superposed masonry appears to aid in keeping the cement in place and the bricks in position; so that the horizontal joints remain gas-tight and are capable of holding zinc vapor without leaking longer than the vertical joints. Since leaks in a zinc retort soon render the retort inefficient in operation, on account of loss of zinc vapor, and finally render it entirely inoperative on account of the tendency of such leaks to increase progressively in size, the life of the retort may be increased by increasing the vapor-tightness of its weakest points; that is, the vertical joints between adjacent bricks.

Numerous attempts have been made in zinc reduction retort construction to render vertical joints tighter by the use of tongue-and-groove brick of the known type frequently used in refractory masonry structures. These bricks have the advantage of offering a tortuous or zig-zag path in the vertical joints when the tongue and grooves mesh with one another at the ends of adjacent bricks. Such a joint obviously provides a longer filler of cement across the ends of the bricks opposed to one another, which assists in keeping the joint from springing a leak.

As a result of my investigation, I have determined on a type of vertical joint in the construction of built-up retorts with refractory bricks that has the advantages of a tongue-and-groove joint to an increased degree. A tortuous or zig-zag filler of cement, similar to that obtained in the case of a tongue-and-groove joint, but following a more sinuous path than does that in the conventional tongue-and-groove joint, is provided. Furthermore, the risk of failure to fill the vertical tongue-and-groove joints with cement is obviated. Other advantages are obtained as will be clear from the description given below.

The present invention accordingly contemplates a metallurgical furnace chamber, and more particularly a zinc vapor-tight reduction retort, comprising a non-permeable refractory wall built of refractory brick with complementary vertical grooves in opposite end faces adapted to form vertical holes, and refractory plugs fitting in the vertical holes so that adjacent bricks are not wedged apart and superposed courses of brick are not rigidly tied together. The refractory bricks are laid in an ordinary wall construction course by course, and the refractory plugs are embedded in cement in the holes formed by complementary vertical grooves, in such a way as to avoid wedging bricks and courses apart.

The refractory bricks used are of such size and shape and are so laid that expansion and contraction may take place without transferring any objectionable strain on adjacent bricks. Expansion and contraction effects in individual bricks are minimized by employing bricks constructed of temperature resistant material having a relatively low coefficient of expansion, particularly at the temperature normally employed in the metallurgical furnace. The bricks also have good heat conductivity, particularly for the construction of zinc retorts; which are generally externally heated. Such materials as silicon carbide, magnesium oxide, aluminum oxide, zirconium oxide and zirconium silicate may be employed to build the bricks.

The refractory plugs are made of any suitable material. They are preferably made of the same material as the bricks. It will be clear that they may be made in any suitable size and shape, depending largely on the size and shape of the vertical grooves into which they are to be fitted.

The built-up chamber or retort of the present invention is to be distinguished from the one-piece or monolithic retorts commonly used in the reduction of zinciferous materials. Even though the refractory materials are carefully selected, monolithic retorts made therefrom tend to spring cracks during operating conditions. This is particularly true of the so-called Belgian type retorts which are formed by pressure molding with plastic refractory clay materials. These retorts are then baked in order to harden and strengthen them. Stresses and strains set up in any section of the retort are readily transferred to other parts of the retort, and in this manner tend to crack the retort wall. The monolithic nature of the retort does not provide a relief for these stresses and strains. In the construction contemplated by the present invention, on the other hand, each individual brick will for the most part be able to handle its own stresses and strains due

to expansion and contraction effects without rupture; and without transferring them to an adjacent brick. This safety feature is provided in part by the bricks themselves and in part by the cement employed in the novel joints.

In order to avoid the formation of a monolithic structure, a joint filler or cement is employed between the bricks that is at least slightly plastic under normal operating conditions. When the built-up retort or chamber with its many joints is brought to an elevated temperature, small stresses and strains are unavoidably set up. Differences in expansion in different parts of the structure are also set up. These stresses and strains, expansion and contraction effects, in the individual bricks, may be largely relieved by flow in the cement or filler in the joints. In this manner, cracks are substantially avoided.

Any suitable mortar or cement material may be employed in the joints. In the practice of the present invention, an admixture of finely divided silicon carbide, a small amount of a binder, such as dried sulfite liquor, for example, and a small amount of clay have been employed. The cement is made sufficiently plastic by the addition of regulated amounts of water; but it has sufficient density to leave a real body of silicon carbide in the joints when the water is evaporated.

Refractory bricks of various sizes and shapes may be employed. Refractory bricks of the standard rectangular type are advantageously used, particularly in the construction of a rectangularly shaped retort. Circular bricks may of course be employed in the construction of circular or cylindrical retorts. The brick are provided with the necessary complementary grooves along their ends, so that when the refractory plugs are inserted a joint is provided that follows a tortuous or zig-zag path characteristic of the invention.

The vertical grooves in the bricks are so placed as to lie opposite each other or vis-a-vis when the bricks are laid in courses to form a wall. An open hole is left in or near the center of the vertical joints. It will be clear that this hole may be made to assume any desired shape, by fixing the shape of the vertical grooves in the ends of the bricks. The hole is then filled by a plug of such size, that it, together with sufficient cement to join it with the adjacent bricks, can be inserted in the hole without forcing the bricks apart; and thus avoid disturbing their even and accurate arrangement in the wall. The refractory plugs, furthermore, are so fitted in each vertical groove or hole that they will not force apart the lower or upper course of bricks. The bricks are preferably laid in such a manner that the vertical joints are in staggered relation one to the other.

These and various other features of the present invention will undoubtedly be better understood if reference is made to the accompanying drawing, taken in conjunction with the following description, in which:

Fig. 1 is a perspective view of a brick with vertical semi-circular grooves in the same;

Fig. 2 is a detailed view of a circularly shaped plug adapted to be inserted in the grooves between adjacent bricks of the type illustrated in Fig. 1;

Fig. 3 is a perspective view of a rectangularly shaped built-up vertical zinc retort provided with vertical joints according to a practice of the invention, and constructed with bricks of the type illustrated by Fig. 1 and plugs of the type illustrated by Fig. 2;

Fig. 4 is an elevation of a wall constructed in accordance with the invention showing a vertical section through a joint with a plug and cement in place;

Fig. 5 is a section on the line **5—5** of Fig. 4, showing a detail view of two bricks of the type illustrated by Fig. 1 and the plug illustrated by Fig. 2 assembled in place in the wall;

Fig. 6 is a perspective view in part of a brick with vertical semi-elliptical grooves in the ends;

Fig. 7 is a detailed view of an elliptically shaped plug adapted to be inserted in the grooves between adjacent bricks of the type illustrated by Fig. 6;

Fig. 8 is a transverse horizontal section in part, illustrating the plug of Fig. 7 in position when employing bricks of the kind illustrated by Fig. 6.

Fig. 9 is a perspective view of a brick with vertical semi-diamond shaped grooves in the ends;

Fig. 10 is a perspective view in part of a brick with vertical semi-square grooves in the ends;

Fig. 11 is a detailed view of a plug adapted to be inserted in the vertical semi-diamond shaped grooves of the bricks illustrated by Fig. 9, as well as in the vertical semi-square shaped grooves of the bricks illustrated by Fig. 10;

Fig. 12 is a transverse horizontal section of a vertical joint in part illustrating the plug of Fig. 11 in position when employing bricks of the kind illustrated by Fig. 9;

Fig. 13 is a transverse horizontal section of a vertical joint in part illustrating the plug of Fig. 11 in position when employing bricks of the kind illustrated by Fig. 10.

Referring to Fig. 3, it will be seen that the rectangularly shaped vertical retort is constructed of refractory bricks **20**, illustrated in Fig. 1. They are laid in horizontal courses, one course being superposed on another; and so that their vertical joints are in staggered relation one to the other. The bricks are provided in the instant case with vertical semi-circular grooves **21** at each end. These grooves are complementary so that when the bricks are laid end to end they form a common vertical hole or groove. Vertical plugs **22** fit into the vertical grooves. An even layer of cement **23** is provided between adjacent bricks and around the plugs.

It will be clear from the modifications shown in the drawing that various types of brick, groove and plug constructions may be employed in the practice of the invention. Instead of semi-circular grooves, semi-elliptical **24**, semi-diamond **25** and semi-square **26** grooves may be used, such as shown in Figs. 6, 9 and 10, respectively. Thus, the plugs may or may not be provided with protruding ears or shoulders **27**. In the case of the detailed views of the circular plug of Fig. 2, the elliptical plug **28** of Fig. 7, and the square or rectangular plug **29** of Fig. 11, they are provided with laterally extending and vertically disposed ears or ribs.

The present preferred method of constructing the wall of a vertical retort in accordance with the invention is as follows: Preliminarily to the actual construction of the wall, the bricks, which should generally have their abutting flat surfaces machined or ground, for each horizontal course are laid cut on a straight edge placed on any suitable flat surface and are carefully matched for thickness, square ends and for over-all length. The refractory plugs are fitted into each vertical hole formed by the complementary grooves in the ends of the bricks, the ears or ribs being ground down, if necessary, so that no great pressure need be applied to insert the plugs into the vertical

holes; but at the same time the ears or ribs preferably come into easy contact with the walls of the grooves. The bricks and plugs are advantageously numbered in order to facilitate the laying out of the course in the retort setting. They are also advantageously soaked in water, so as to reduce absorption of water from the mortar or cement employed.

A horizontal course is first laid in the usual manner, using every effort to have the joints filled with cement. The ends of the bricks should be accurately fitted. Wedges are inserted between each end of the course and the end wall of the heating laboratory or chamber in which the retort is built; in order to prevent the vertical joints in the course from widening when the plugs are inserted in the vertical grooves.

Cement is then placed in the bottom of the vertical grooves or holes, in which cement from the horizontal joint beneath may already be present. In the case of a superposed course, the cement at the bottom of each groove is stirred in order to break up the surface, and enough fresh cement to fill the hole about one-third is added. The entire brick surface of the hole is coated with cement by stirring, using a suitably sized stick or stirrer for the purpose.

The plugs are "buttered" with cement, between the ears or projecting edges and on the bottom, and are then gently pressed into position, so that the excess cement at the bottom of the hole is extruded around the plug, thus providing a cement filled joint. The result of this method of construction is that the plug is imbedded in cement, resting on a bed of cement attached to the horizontal joint below and covered by a cap of cement attached to the horizontal joint above. Such a use of the refractory plugs tends to prevent failure to fill the vertical joints with cement. The courses of brick are preferably so laid that the vertical joints are staggered.

It will be observed that the refractory plugs of the form specifically described are not, strictly speaking, dowels or tie rods; that is to say, they do not lock one course of brick to the course of brick above it or below it. The courses of brick should not be locked together for the following reason: Walls of refractory furnaces, and in particular walls of vertical retorts, exposed to variations in temperature should have a certain flexibility; that is, each course of brick should be able to move during expansion or contraction independently to a certain extent of the adjacent courses of brick. If the courses of brick were locked firmly together by means of dowels or tie-rods in accordance with the known methods of tying masonry together, the stresses and strains produced by the differential expansion or contraction of the masonry on account of variations in temperature would soon result in cracks. In case plugs are used in the form of dowels or tie-rods in the practice of the present invention they must be set loosely enough to avoid tying the courses of brick firmly together. It will be further noted that the refractory plugs inserted between the bricks are not intended as wedges to force the bricks into position; in fact, care must be taken that these plugs when inserted do not move the bricks from their position, since this would displace their arrangement and distort and weaken the joints. The vertical holes formed by the complementary grooves between adjacent bricks have no reentrant angles and the refractory plugs do not key adjacent bricks together.

At least a three-fold advantage is secured by the use of refractory walls constructed in this manner for zinc retorts. In the first place, the vertical joints penetrating the wall of the vertical zinc retort are rendered tortuous by the presence of the plugs so that these joints retain more efficiently the zinc vapor and other gases under pressure in the retort during the distillation of the charge of zinciferous material mixed with the reducing agent therein. The ears on the plugs assist in rendering the vertical joints gas-tight by narrowing the joint at its tortuous portion. In the second place, the operation of inserting the plugs tends to force a certain amount of added cement into the vertical joints so that there is less risk of leaving part of the vertical joints deficient in cement. And, in the third place, the presence of the relatively large amount of cement in the joints insured by this method of construction tends to make them self-healing; on account of the plasticity of the cement at operating temperatures slight ruptures in the cement joints tend to close up. All these circumstances tend to reinforce the weakest element in such a wall and thus to increase the life of the retorts constructed in this way.

It will be understood that the particular forms of groove and plug shown herein are given merely for the purpose of example and do not limit the invention; thus the grooves are shown as semi-circular in cross-section so as to form a cylindrical hole; and the plugs are shown as cylindrical in form with four ears. Obviously the number of ears may be varied as desired, or they may even in some circumstances be omitted. Likewise the grooves need not be semi-circular, but may be of any appropriate shape. The plugs intended for insertion in the grooves must conform at least roughly in shape thereto so as to fit loosely therein, so that they can be inserted without wedging the bricks apart in the construction of the wall; and if they are inserted as dowels, they should fit loosely enough to permit differential expansion and contraction of the different courses of brick.

While the invention has been particularly described in regard to its practice in the case of a vertical reduction retort in zinc metallurgical furnaces, it will be understood that the principles of the invention are applicable in other metallurgical structures as well. Any suitable metallurgical chamber or furnace wall may be constructed in accordance with the practice of the present invention.

I claim:

1. In a zinc metallurgical furnace, the combination comprising a zinc vapor-tight retort built-up of flat faced refractory bricks having good heat conductivity and a low coefficient of expansion, each of said refractory bricks having at least one vertical complementary groove along opposite ends to match a similar groove in an adjacent brick, refractory plugs smaller than each set of combined grooves fitting therein so that adjacent bricks are not wedged apart and superposed courses are not rigidly tied together, and a cement disposed between adjacent bricks and around said plugs that is slightly plastic under normal operating conditions so that expansion and contraction effects in one brick are not unduly carried to an adjacent brick.

2. A method of constructing a gas-tight furnace wall of bricks joined by cement, which comprises laying superposed courses of bricks bonded

by cement, said bricks being provided with complementary vertical grooves along their opposing ends, packing the vertical joints between the bricks with cement by partly filling the holes formed by the complementary grooves with cement and then forcing said cement into the vertical joints by inserting refractory plugs into the holes, said plugs fitting the holes too loosely to force the bricks apart.

3. In a zinc metallurgical furnace, the combination comprising a zinc vapor-tight retort constructed of refractory bricks having complementary vertical grooves along their adjacent vertical faces, refractory plugs not longer than the height of the individual bricks fitting completely within said vertical grooves and sufficiently small to prevent wedging apart of adjacent bricks, and a cement slightly plastic at elevated temperatures separating adjacent bricks from one another and from the intervening plug.

4. In a zinc metallurgical furnace, the combination comprising a zinc vapor-tight retort constructed of refractory bricks having complementary vertical grooves along their adjacent vertical faces, refractory plugs of no greater length than the height of the brick positioned in said vertical grooves and sufficiently spaced from the adjacent bricks to avoid wedging the bricks apart, and a cement slightly plastic under normal operating conditions separating adjacent bricks from one another so that expansion and contraction in one brick are not unduly carried to an adjacent brick.

5. A zinc retort built up of refractory bricks having complementary grooves along adjacent vertical faces providing vertical holes without reentrant angles between adjacent bricks when assembled in the built-up retort structure, refractory plugs positioned in the vertical holes between adjacent bricks, said plugs having a height no greater than the thickness of the brick and having their width and breadth less than the width and breadth of the vertical holes in which the plugs are positioned, so that adjacent bricks are neither wedged apart nor keyed together by the plugs and a cement disposed between adjacent bricks and around said plugs.

6. A zinc retort built up of refractory bricks having complementary grooves along adjacent vertical faces providing vertical holes without reentrant angles between adjacent bricks when assembled in the built-up retort structure, refractory plugs positioned in the vertical holes between adjacent bricks, said plugs having a height no greater than the thickness of the brick and having their width and breadth less than the width and breadth of the vertical holes in which the plugs are positioned, so that adjacent bricks are neither wedged apart nor keyed together by the plugs, and cement separating said faces of adjacent bricks from one another and from the intervening plug.

7. A zinc retort built of refractory bricks with staggered vertical joints, said bricks being provided with complementary vertical grooves along their opposing ends adapted to form vertical holes of convex cross-section when the bricks are assembled, refractory plugs positioned in the vertical holes between adjacent bricks, said plugs having a height no greater than the thickness of the brick and having their width and breadth less than the width and breadth of the vertical holes in which the plugs are positioned so that adjacent bricks are neither wedged apart nor keyed together and a cement disposed between adjacent bricks and around said plugs.

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