May 19, 1931. O. NYGAARD 1,806,113

FURNACE WALL

Filed Feb. 4, 1926 2 Sheets-Sheet 1

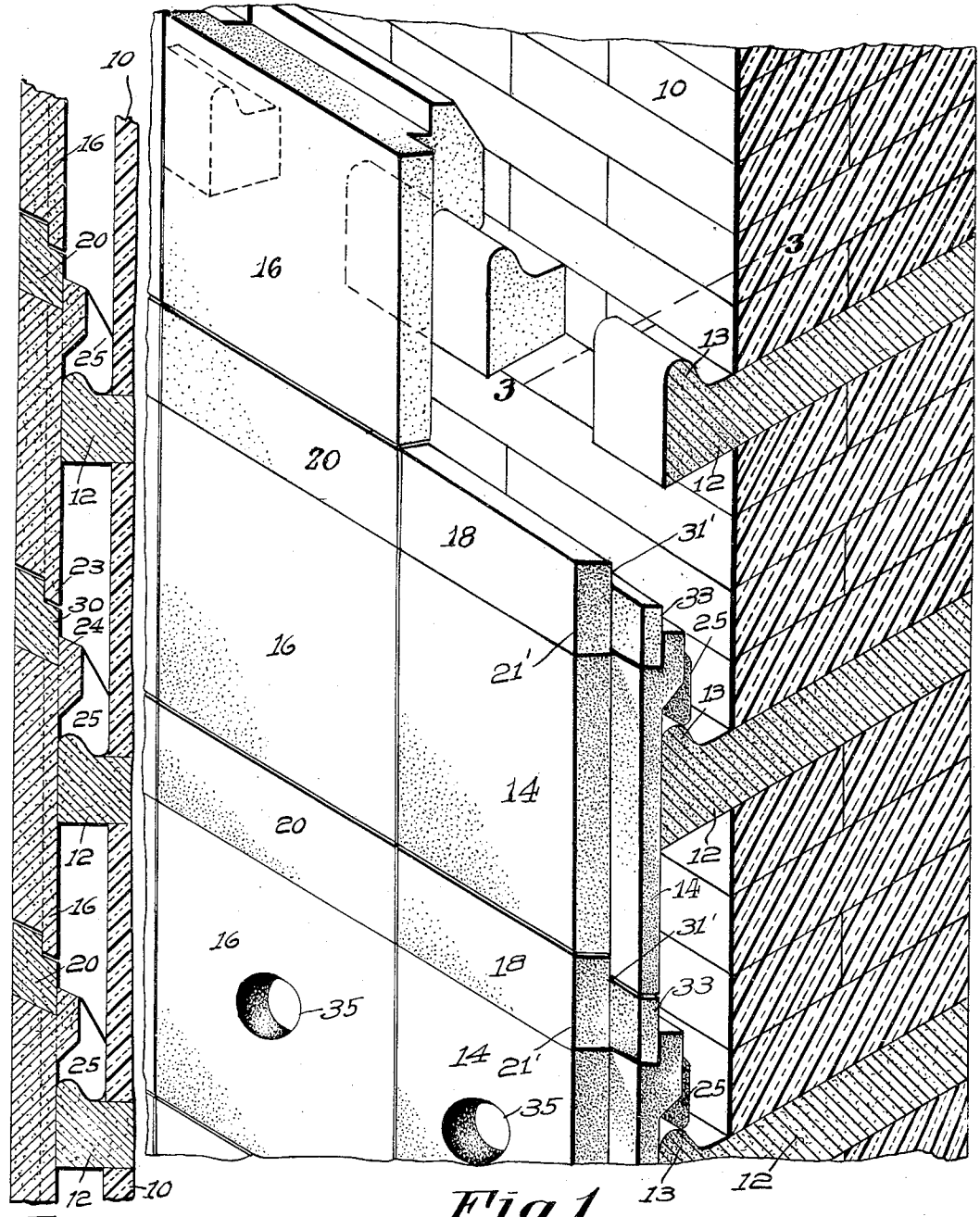

Fig.2

Fig.1

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FURNACE WALL

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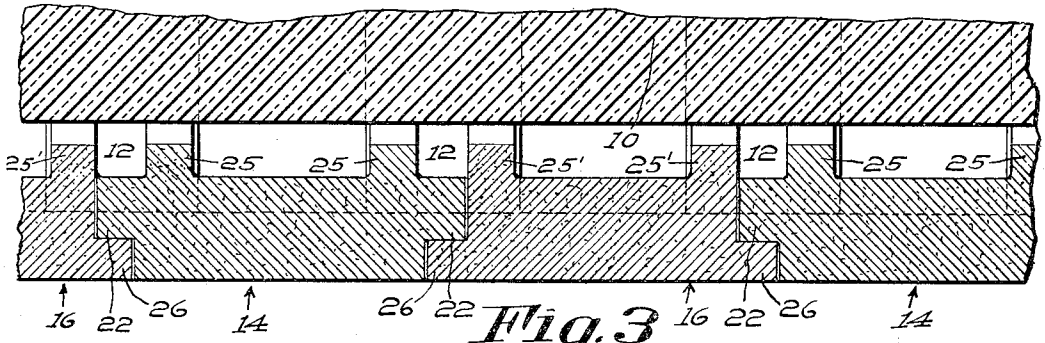

Fig. 3

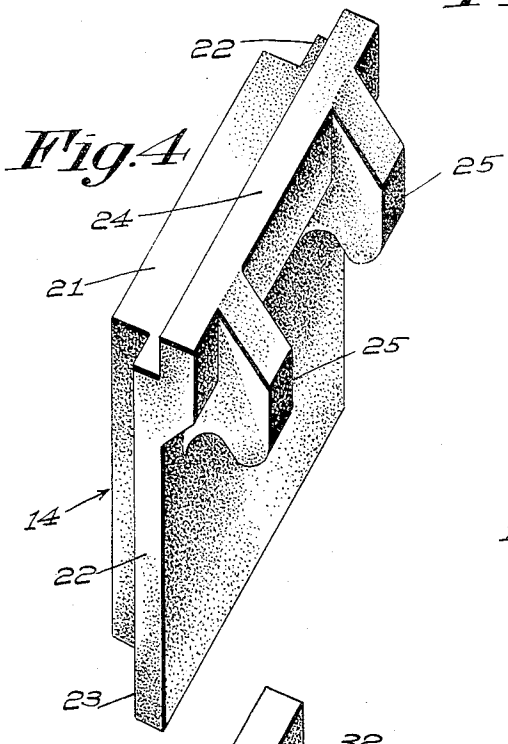

Fig. 4

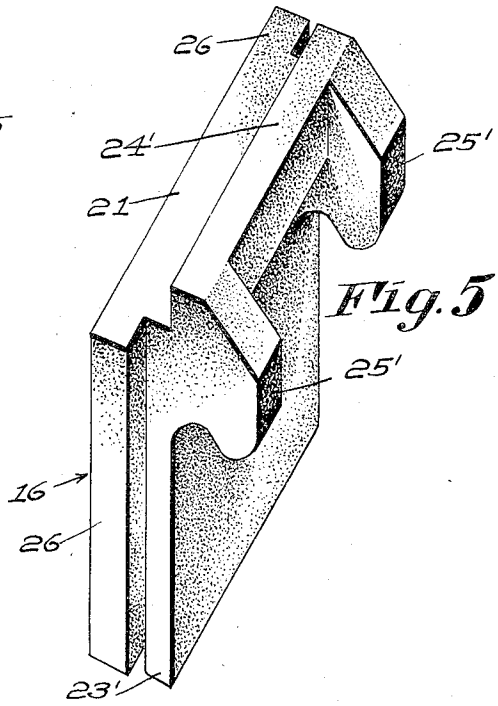

Fig. 5

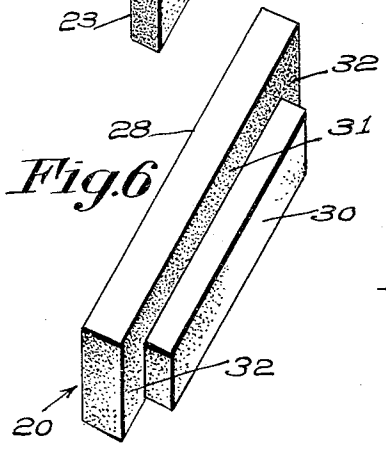

Fig. 6

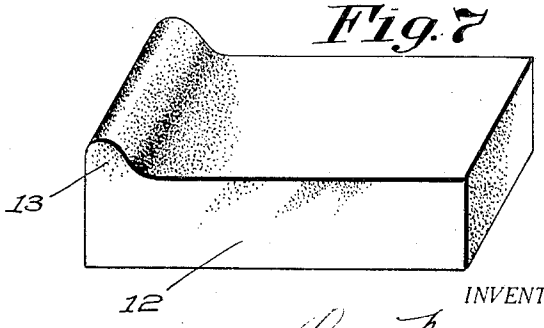

Fig. 7

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Patented May 19, 1931 1,806,113

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FURNACE WALL

Application filed February 4, 1926. Serial No. 85,916.

This invention relates to furnace walls, and more particularly to the construction of inner facings or linings for the walls of furnaces wherein the wall is subjected to an extreme and at times an uneven heat such as pulverized fuel furnaces, although the invention is highly useful also in any furnace wherein the wall thereof is subjected to high temperatures in part or in whole.

The main object of the invention is to provide a furnace wall that will successfully avoid the difficulties encountered by reason of the unavoidable expansion of the brick lining due to the high temperatures to which the wall is subjected. A subsidiary, but nevertheless an important object, is the provision of a wall of which any impaired portion can readily be repaired without demolishing the adjoining uninjured portions and which is replaceable in whole or in part at a minimum of both time and expense. My furnace wall, having these characteristic features, has the further advantage that it can be built at a much less cost than other wall constructions.

To the accomplishment of these objects and such others as may hereinafter appear, as will readily be understood by those skilled in the art from the following description, the invention comprises the novel constructional features, arrangement and combination of parts for furnace walls hereinafter described in their preferred form and then particularly pointed out in the appended claims.

The various features of the invention will best be understood from a description of the best form at present known to me, illustrated in the accompanying drawings, in which:

Figure 1 is a view, in perspective, of a portion of a masonry wall for furnaces lined with an inner facing having the novel characteristics of the present invention, it being understood that the novel facing may, and preferably does, completely cover the masonry wall;

Fig. 2 is a view of several tiers of the wall in vertical section, the masonry portion thereof being shown broken away;

Fig. 3 is a plan view, in horizontal section, through the complete wall below the line 3—3 of Fig. 1;

Figs. 4 and 5 are views, in perspective, of the two preferred types of inter-engaging suspended brick aprons used in building a paneled facing construction;

Fig. 6 is a view, in perspective, of one type of filler brick that is inter-engaged with another type shown in Fig. 1 to form intermediate tiers between the tiers of suspended or apron brick; and

Fig. 7 is a view, in perspective, of one type of support, to be built into the permanent wall, on which a tier of the brick apron shown in Figs. 4 and 5 is removably suspended.

In the embodiment of the invention illustrated in the drawings 10 indicates the permanent furnace wall which differs from the usual masonry wall by having built into it successive, vertically-spaced, horizontal rows of projecting supports which may conveniently be the bricks 12 (Fig. 7), although the invention includes within its scope other equivalent supporting members combined with masonry or other types of permanent wall. The bricks 12 are designed to removably support a refractory inner facing or lining which covers the wall 10 from top to bottom. Each brick 12 conveniently has a projection at its outer edge in the form of an upwardly turned lug 13 which may have a convex upper face as shown best in Fig. 7. It will be understood from the broken away portion of Fig. 1 that the lining supports 12 of each series are spaced apart, providing for free circulation of air, behind the lining, between and about them.

Those skilled in the art are aware that the high temperature to which a furnace lining is subjected causes considerable expansion of its bricks with a consequent compression which frequently causes portions of the lining to collapse and require replacement. When the lining is built as a masonry wall, i. e. with its bricks bonded together by high temperature cement or fire clay, the repair work is not only difficult but also slow and expensive. According to the present inven-

tion the lining that is suspended from the projecting lining supports 12 is so constructed that no cement or other bond is required between the individual bricks and by the use of slip-type or sealed joints at all meeting edges the bricks are assembled in such relation to each other that the greatest degree of heat can be endured and the inevitable expansion can take place without injury. At the same time a free circulation of air, confined to the space behind the apron, is maintained. The lining supports 12 are special bricks bonded into the permanent wall at regularly spaced intervals, in selected tiers or courses thereof, being thus located over the inner face of the permanent wall in horizontal and vertical alignment with each other. This arrangement, with a like arrangement of suspension means on the lining bricks, provides a highly important and novel feature in air-cooled furnace wall construction which will be referred to after the constructional features of the lining have been explained. These features form highly important and novel characteristics of the present invention. Experts in the art will recognize, that with the danger of deterioration from undue expansion eliminated, the initial cost can be reduced by the use of a much thinner brick; and that the absence of a cementitious, fire clay or other bond, when the bricks are constructed and assembled in the manner now to be described, enables speedy repair of any portion of the lining.

The wall supports 12 provide for the suspension of the lining or facing thereon, as shown best in Figs. 1 and 2. In building the lining, bricks are used having the novel characteristics shown in Figs. 4, 5 and 6. Each horizontal row of the projecting supports 12, sustains a tier of lining brick consisting of alternately arranged inter-engaging brick aprons 14 and 16 (Figs. 4 and 5). The relation of the vertical spacing of the horizontal rows of supports 12, to the vertical dimension of the bricks 14 and 16, purposely is such that after successive tiers formed of the apron bricks have been suspended, a space or horizontal channel is left between each tier. These channels are filled, and the continuity of the lining is completed, by introducing in these channels alternately arranged inter-engaging filler bricks 18 and 20 (Figs. 1 and 6).

The type of refractory lining just described in general terms, provides for ready removability and replacement of any tier, or of any portion of the lining as will be better understood from the following detailed description. It will be observed that the vertical rows of lining brick, for example a row composed of alternating brick aprons 14 and filler brick 18, or of brick aprons 16 and filler brick 20, produce a wall constructed of a series of adjoining vertical panels, that is, the vertical joints between the bricks in adjoining horizontal rows are not staggered as is customary in a masonry wall. This construction is particularly advantageous in repair work as will presently be explained.

Each brick apron 14 (Fig. 4) comprises a body 21 of the desired thickness, two rear side-flanges 22 and a bottom-flange 23 extending from the body material, a top-flange 24 in a plane at the rear of the body and preferably, although not necessarily, two depending suspension lugs 25 each of which may have its lower face concavely curved, or otherwise recessed to fit over the upwardly projecting lugs 13 on the supports 12. The lateral spacing of the lugs 25 is such that when a brick 14 is suspended one such lug seats and locks on one edge of the support 12 while the other seats and locks on the adjacent edge of the next support 12, the entire row being thus suspended vertically like an apron (see Figs. 2 and 3). Attention is called to the fact that the top and bottom edges of the brick aprons 14 are oblique to the front and rear faces, the slope being inward and downward after the brick is suspended (see Fig. 2). The brick aprons 16 are generally similar to the brick aprons 14 except that each brick 16 is provided with front side-flanges 26 instead of rear side-flanges. The bottom and top-flanges 23′ and 24′ on each brick 16 are the same as the like flanges on a brick 14 except that they are shorter, and the suspension lugs 25′ are just the same in both shape and lateral spacing. Beveled top and bottom edges are provided on each brick 16 of the same obliquity as those of a brick 14.

In building a suspended tier or lining apron from the bricks 14 and 16 they are hung alternately by their rear lugs 25 and 25′ on the supports 12, the rear side-flanges of the bricks 14 underlying the front side-flanges of the bricks 16, (see Fig. 1). The lugs 25 and 25′ interlock firmly with the lugs 13 and draw the rear faces of the suspended bricks snugly against the end faces of the projecting bricks or other element 12 forming the supporting medium (see Fig. 2). The bricks in any such tier are not forced together tightly laterally but are purposely hung with sufficient space left between them to allow for expansion.

To complete the continuity of the lining the filler bricks 18 and 20 are seated in the horizontal channels already referred to, between the tiers formed of suspended brick, aprons 14 and 16. Each filler brick 20 (Fig. 6) comprises a body 28 and a rear key member 30, the bottom edge of which is flush with the bottom edge of the body 28 (see Fig. 2) but which is so proportioned as to be both narrower and shorter than the body. This provides a front top-flange 31 and two

front side-flanges 32. The length of the body 28 is the same as the width of the face of a suspended brick apron 16 since it is to be assembled in the vertical panel of which the suspended brick 16 form a part. Likewise the length of the key member 30 is the same as that of the bottom-flange 23′ on a suspended brick apron 16. The continuity of the vertical edges of the panel are thus preserved. Each filler brick 18 (shown only in Fig. 1) has a body 28′ equal in length to the face of a suspended brick apron 14 and its key member 30 is so proportioned as to provide two rear side-flanges 33 and a front top-flange 31′, this key being of the same length as the bottom-flange 23 on the suspended brick 14 (see Fig. 1). This preserves the continuity of the vertical edges of the panel composed of the suspended bricks 14 and filler bricks 18. The filler bricks of both types have beveled top and bottom edges of the same obliquity as the like edges on the suspended bricks.

In assembling the filler bricks with the lining aprons formed by the tiers of suspended bricks, first a filler brick 18 is seated between each pair of vertically adjacent bricks 14 of several panels, and then a brick 20 is seated between each pair of vertically adjacent bricks 16 of the adjacent panels and so on until the facing is completed. The filler bricks are retained in these spaces by reason of the obliquity of their seating and by the top-flanges 24 and 24′ of the apron bricks which form rear stops. The vertical dimension of each filler brick is such that it fits loosely in the channel between the tiers of suspended brick, thus allowing for expansion (see Figs. 1 and 2).

The loose joining of all the bricks used in forming the lining and the absence of any bonding material whatever, permits free expansion of each individual brick both vertically and laterally, so that danger of crushing from this expansion is avoided and much thinner brick may be used than those now available for masonry or bonded linings.

It will be observed that the lugs 25 and 25′ and supporting bricks 12 maintain the novel suspended lining or facing spaced from the permanent furnace wall 10 and, as heretofore stated, there is a free circulation of air through this space. This may be a forced circulation, if desired, the usual intake and exhaust passages through the wall 10 being provided. The lugs for suspending the lining bricks are so spaced thereon as to provide both horizontal and vertical rows having the same spacing as the projecting lining supporting bricks bonded into the permanent wall. The reason for locating the lugs on the suspended members so that they also will be in horizontal and vertical alignment with each other after assembly, is that it affords the important provision for building wholly vertical or wholly horizontal air passages in the wall. The size and spacing of the lugs on the lining bricks and on the co-operating supporting bricks, both horizontally and vertically, are purposely designed and arranged as described so that it is only necessary to set out across the air space against the inner lining a sufficient number of the standard size fire bricks, from which the outer wall is built, to close any selected series of spaces between the lugs. Thus free and unobstructed air passages extending in any direction desired can be formed at will at very little expense since no extra shapes are necessary. Also, a wall thus constructed can readily be sectioned off in either direction as may be advantageous for a particular installation. For various reasons it is highly desirable to circulate more air through a certain area or section of the wall than through another section, and it is equally important to be able to change the circulation of air from horizontal to vertical, or vice versa, as this will avoid by-passing certain parts of the wall and result in an even cooling of the lining. The overlapping flanges on the bricks of the facing will prevent the air in this circulation or cooling chamber from passing through the facing to the combustion chamber. If it is deemed advantageous to admit air into the combustion chamber or into the fuel-bed, the bricks of as many tiers as may be required for this purpose may be perforated, as shown at 35 (Fig. 1) thus providing air ejection passages from the air chamber behind the facing, to the fire.

Assuming that the lining has been in use and that a suspended brick, for example the central brick 14 of Fig. 1, has become cracked for some reason, a replacement would be made as follows. First the filler brick 20 above and to the left (or right) of the damaged brick is removed. The absence of cement and the short key member 30 of this filler brick permits it to be removed without displacing any adjacent brick. The filler brick 18 directly above the damaged brick may then be slipped sidewise, until its flange 33 is cleared of the next overlapping flange, and finally removed. Suspended brick 16 to the left (or right) of the damaged brick may then be forced upward until its lugs 25′ are clear of the lugs 13 on supports 12, when it may be removed. This gives sufficient space to slide the damaged brick 14 sidewise, which is permitted by the slip joint engagement at the meeting edges of the bricks, until its side flange 22 is clear of the adjoining suspended brick 16 whereupon it may be lifted from the supports and removed. Replacement is accomplished by reversing these

steps. It will be observed that if a suspended brick 16 is damaged it may be removed and replaced by taking out only the filler brick above it.

Attention is especially called to the fact that the novel and improved furnace wall described, while of such thinness that it will heat and cool evenly, still provides ample constructional strength and yet successfully eliminates structural strains because of the provision for expansion of each unit of the wall both horizontally and vertically. All parts of the wall, in large or small sections, are free to expand under heat, thus preventing spalling at any point on the wall surface however uneven the heat may be. The air space, permitting free circulation of air in all directions behind the facing of refractory brick, is of importance because the thin brick used may be thoroughly cooled by this circulation and thus still maintain their strength. Of equal importance are the overlapped expansion joints which provide for a continuity of the heat absorbing lining and also make a bonded brick construction unnecessary.

One of the features of the lining that adds materially to its efficiency and life resides in the mode of supporting the filler bricks. The filler bricks, due to their position just below each horizontal expansion joint, are loose in the wall and, like the suspended bricks, are comparatively thin. The usual vibration set up by the operation of the furnace is sufficient to shake any insecurely seated brick into the furnace. Any appreciable accumulation of clinkers on the inner face of these filler bricks tends to overbalance them and would eventually tip them into the furnace unless securely seated. The inclined surface at the upper edge of the underlying row of suspended bricks upon which a row of filler bricks is supported and the complemental inclined surface at the lower edges of the filler bricks, co-act to cause the filler bricks continually to gravitate outward, especially under jarring or vibration, and to counterbalance any excess weight from clinkers that may be formed at the inner or fire face. Thus the entire lining remains intact under all normal conditions of furnace operation notwithstanding that, apparently, some bricks are quite loose in the wall in order to gain other advantages hereinbefore described.

Particular attention is called to the highly advantageous feature of construction provided by the brick aprons which have been termed such because of their manner of suspension, but it should be distinctly understood that the invention is not limited to brick aprons having the illustrated suspension means but includes within its scope other means for removably supporting the facing wall bricks in spaced relation to the permanent furnace wall, accordingly in the appended claims characterizing features of the invention are set forth by the intentional use of generic terms and expressions inclusive of various modifications.

The nature and scope of the invention having been indicated, and its preferred embodiment having been specifically described, what is claimed as new, is:—

1. In combination with a permanent furnace wall a refractory lining comprising successive horizontal, vertically spaced tiers of bricks each being one brick in height suspended from the permanent wall, rows of filler bricks seated loosely in the spaces between said tiers, and means on the rear edge of each suspended brick for retaining said filler bricks within said spaces.

2. In a refractory lining for furnace walls a row of bricks comprising adjacent pairs of bricks arranged horizontally, each pair composed of one brick having two front side flanges and a rear bottom flange and one brick having two rear side flanges and a rear bottom flange whereby the adjacent side flanges of each two adjoining bricks are lapped after assembly.

3. In a refractory lining for furnace walls a row of bricks comprising adjacent pairs of bricks arranged horizontally, each pair composed of one brick having two front side flanges and a rear bottom flange and one brick having two rear side flanges and a rear bottom flange whereby the adjacent side flanges of each two adjoining bricks are lapped after assembly, and means on said bricks for suspending them on the furnace wall.

4. In a furnace wall an outer wall, a refractory lining consisting of a plurality of horizontal rows of brick units, each row comprising a plurality of unbonded units independently supported on said outer wall assembled with their lateral edges in overlapped, spaced relation, whereby to provide expansion joints permitting lateral expansion of each unit independently of every other unit in the row, there also being like expansion joints between each row permitting vertical expansion of each unit independently of every other unit.

5. A furnace wall construction comprising a permanent wall and an unbonded refractory lining therefor composed of parallel vertical panels each panel extending from top to bottom of the area to be lined and each panel being suspended on said permanent wall independently of each other panel, and continuous, vertical sealed expansion joints between said panels formed by overlapping flanges at the meeting edges of adjoining panels.

6. An expansible refractory brick lining for furnace walls consisting of a plurality of vertical panels side by side, each panel com-

prising a plurality of brick units each of which is as wide as the panel, loosely engaging rabbeted horizontal edges on the adjoining units in each panel, and loosely engaging rabbeted vertical edges on the abutting units of adjacent panels.

7. An expansible refractory brick lining for furnace walls consisting of a plurality of vertical panels side by side, each panel comprising a plurality of brick units, the units composing the entire wall being of such size and arrangement as to create continuous horizontal expansion joints across the panels and continuous vertical expansion joints between the panels, and each of said joints being sealed by loosely engaging rabbets on the edges of units which abut to produce said joints.

8. A permanent furnace wall, and a removable inner lining therefor adapted for operation under sustained high temperatures, said lining comprising vertically disposed horizontal rows each composed of a plurality of brick units, each unit of each row having on its outer face at least one suspension lug of lesser width than the width of the unit, whereby the lugs in any horizontal row will be in spaced relation to each other, and single lining supporting brick members bonded into the permanent wall, projecting inwardly therefrom and positioned thereover to co-operate with said lugs for removably suspending each brick unit of the inner lining in substantially parallel spaced relation to the permanent wall.

9. A furnace wall comprising an inner lining for operation under sustained high temperature comprising a plurality of brick units each having edges which loosely overlap the edges of all surrounding units to permit free expansion of each unit in every direction, a permanent wall, a plurality of projecting supports at the inner face of said permanent wall, and means on the lining units for engaging said supports and holding the outer face of the lining against the inner faces of the supports and in spaced relation to the inner face of said permanent wall.

10. A furnace wall comprising a permanent wall having projecting lining supporting bricks at its inner face, said supporting bricks being spaced apart both vertically and horizontally forming horizontal and vertical rows of spaced supports, an inner lining of refractory bricks and means on some of the bricks of said lining for suspending them from and in front of said supports providing continuous vertical and horizontal air passages between said lining and permanent wall.

11. A furnace wall construction comprising a permanent masonry wall and a lining consisting of horizontal rows of relatively thin unbonded refractory brick spaced from the inner face of said permanent wall, said permanent wall being constructed of horizontal rows of bonded brick certain of said rows having bonded therein projecting lining supporting bricks, there being a plurality of such projecting bricks in spaced relation in each of said bonded rows, certain rows of said lining bricks being held in said spaced relation to said permanent wall by suspension from said projecting bricks and certain other rows of said lining bricks being held in said spaced relation to said permanent wall by being supported upon said suspended lining bricks.

12. A furnace wall construction comprising a permanent wall and an unbonded refractory lining therefor composed of parallel vertical panels each panel consisting of a plurality of refractory bricks assembled in columnar form, every other brick of said plurality being removably suspended on said permanent wall and each brick intermediate any two suspended bricks being slidingly supported on the suspended brick immediately below it and spaced from the suspended brick immediately above it.

13. In a furnace wall construction, a permanent wall and a refractory lining therefor comprising successive, spaced, horizontal rows each composed of unbounded single bricks suspended from the inner face of said permanent wall, and rows of unbonded single filler bricks, one filler brick directly overlying each suspended brick removably supported intermediate said rows of suspended brick, all of the edges of each combination of suspended and filler bricks being rabbeted for a lapped engagement of all of the meeting edges.

14. An inner facing for furnace walls comprising a plurality of horizontal, vertically spaced tiers of brick each tier being one brick in height and each brick of a tier having a flange at both its upper and lower edge projecting into the spaces between tiers, and filler brick seated between said tiers and against the brick flanges.

15. A furnace wall having an outer wall provided with forwardly projecting lugs in horizontal rows, an inner lining comprising vertically spaced substantially horizontal single rows of bricks suspended from said outer wall lugs by at least one depending lug on each of the bricks, a row of unbonded filler bricks in the space between each row of suspended bricks, and means for seating said filler bricks on said suspended bricks in a manner to cause the filler bricks to tend to gravitate toward the outer face of the lining.

16. A furnace wall having an outer wall provided with forwardly projecting lugs in horizontal rows, an inner lining comprising vertically spaced substantially horizontal single rows of bricks suspended from said

outer wall lugs by at least one depending lug on each of the bricks, a row of removable filler bricks in the space between each row of suspended bricks all seated thereon, and said filler bricks forming any row also abutting on their outer faces against portions of the suspended bricks in any adjacent row.

17. In a furnace wall construction, a permanent wall and a refractory lining therefor comprising a plurality of separate, vertically associated units each composed of a single suspended brick and a single filler brick the latter being removably seated above and on the former, and means projecting from the inner face of said permanent wall and from the outer face of each suspended brick for interengagement to suspend each unit from said permanent wall independently of each other unit, the proportion between the vertical spacing of said projecting means on the permanent wall and the height of the suspended brick being such as to permit the removal of a filler brick without disturbing the position of either adjacent suspended brick.

18. In combination with a permanent furnace wall a refractory lining comprising successive horizontal, vertically spaced single rows of bricks suspended from the permanent wall, each row of suspended bricks having its upper edge face in a plane that slopes downwardly and outwardly, and rows of filler bricks of substantially the same thickness as said suspended bricks seated loosely in said spaces, each row of filler bricks having its lower edge face in a plane to engage said sloping upper edge face on a row of suspended bricks and having its inner face in the plane of said lining.

19. A non-metallic furnace wall comprising a permanent brick wall having spaced lining supporting bricks having flat inner ends projecting from its inner face in successive horizontal rows, and a relatively thin lining comprising a plurality of assembled units each unit having means for suspension from said projecting bricks providing for an engagement with the inner ends of said projecting bricks whereby to space said thin lining from the permanent wall, there being expansion joints between adjacent sides of all the lining units so that each lining unit is expansible in every direction independent of each other lining unit.

20. In combination with a permanent furnace wall an inner lining therefor constructed of successive horizontal rows of brick units each unit comprising one brick suspended from a built in support on the inner face of the permanent wall and another brick resting on and wholly supported by the suspended brick, and said rows of units being spaced from each other vertically to accommodate expansion.

21. A furnace wall construction comprising a permanent wall having a plurality of built-in spaced projecting supports, and an inner lining composed of a plurality of horizontal rows of brick units each unit consisting of a lower brick having a rear formation adapted to interlock with at least one of said projecting supports and be rigidly supported thereby and an upper brick unengaged with said projecting supports, the lower edges of said lower bricks in one row and the upper edges of said upper bricks in the underlying row being overlapped.

22. In a furnace wall a lining having a heat-resisting face comprising a plurality of refractory units assembled in wall formation having their adjacent edges overlapped to form slip-type joints, and means for supporting said units spaced from each other both horizontally and vertically to provide for free lateral and vertical expansion between any pair of said units.

23. A heat-resisting facing for permanent furnace walls comprised of a plurality of refractory bricks supported on the permanent wall and a plurality of refractory filler bricks, each filler brick being located vertically between two supported bricks, and the abutting edges of said filler and supported bricks above and below each filler brick being oblique to the plane of the facing in such direction that the filler bricks tend to gravitate outward when seated between each said two supported bricks.

24. A heat-resisting facing for permanent furnace walls comprising a plurality of horizontal rows of members certain of which are refractory bricks supported on the permanent wall and others of which are refractory filler bricks located between two rows of the supported bricks, each row of filler bricks having its upper and lower edges sloping downwardly and outwardly and the rows of supported bricks above and below having their lower and upper edges respectively sloping downwardly and outwardly in a like manner whereby each row of filler brick is caused to continually set more firmly into the facing, and each of said supported bricks above having a depending portion to be engaged by the underlying filler brick to keep it in the plane of the lining.

25. A lining for furnace walls comprising a plurality of vertical panels each composed of a plurality of refractory bricks certain of which are filler brick built into the panel at spaced intervals, the seating of said filler brick between adjacent refractory bricks of the panel being on edge surfaces that slope downwardly and outwardly and against a rear flange on at least one of the adjacent refractory bricks whereby to retain said filler brick in place without bonding.

26. A furnace wall construction comprising a permanent wall and an unbonded refractory brick facing therefor, said permanent wall and said facing each having horizontally spaced members projecting substantially from the plane of the front face of the wall and from the plane of the rear face of the facing for interengaging with each other and removably suspending certain of the bricks of said facing in a plane in front of the members projecting from the permanent wall and maintaining the entire facing spaced a substantial distance from the front face of the permanent wall.

27. In a furnace wall construction a permanent wall and a refractory lining comprising successive spaced horizontal rows of unbonded overlapping bricks, means for suspending said bricks from the permanent wall, and intermediate rows of unbonded overlapping filler bricks.

28. In combination with a permanent furnace wall, an inner facing therefor consisting of a plurality of refractory members assembled in horizontal rows as a wall, each row comprising a plurality of said members and means for suspending independently the members in alternate rows from the permanent wall and for supporting the members in the remaining rows upon the members of said suspended rows, all joints between said members being loose to provide for free expansion both laterally and vertically.

29. A refractory lining for furnaces comprising bricks built in successive tiers and supported in a manner to provide horizontal expansion joints between adjacent tiers, the filler bricks along the top of each tier and immediately below each expansion joint being seated on a downwardly and outwardly inclined surface to cause said bricks continually to gravitate outwardly and to remain seated under the normal conditions of furnace operation tending to throw them inwardly, and means to restrain the filler bricks so seated from gravitational movement out of the plane of the lining.

30. A furnace wall having an outer wall provided with forwardly projecting lugs in horizontal rows, an inner lining comprising vertically spaced horizontal single rows of bricks suspended from said outer wall lugs by at least one depending lug on each of the bricks, and a single row of filler bricks in each space between adjacent rows of suspended bricks.

31. A furnace wall construction comprising a permanent wall and a refactory lining therefor composed of a plurality of brick units, said permanent wall and said units having co-operating means engaging each other by frictional contact only for independently supporting said units and permitting them to shift relatively to the permanent wall under expansion, there being expansion joints between adjacent meeting edges of all the units so that each unit is expansible in every direction independently of each other unit.

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