Oct. 27, 1931. F. I. SHEAHAN 1,829,159

FURNACE CONSTRUCTION

Filed Dec. 9, 1927 2 Sheets-Sheet 1

Fig. 1.

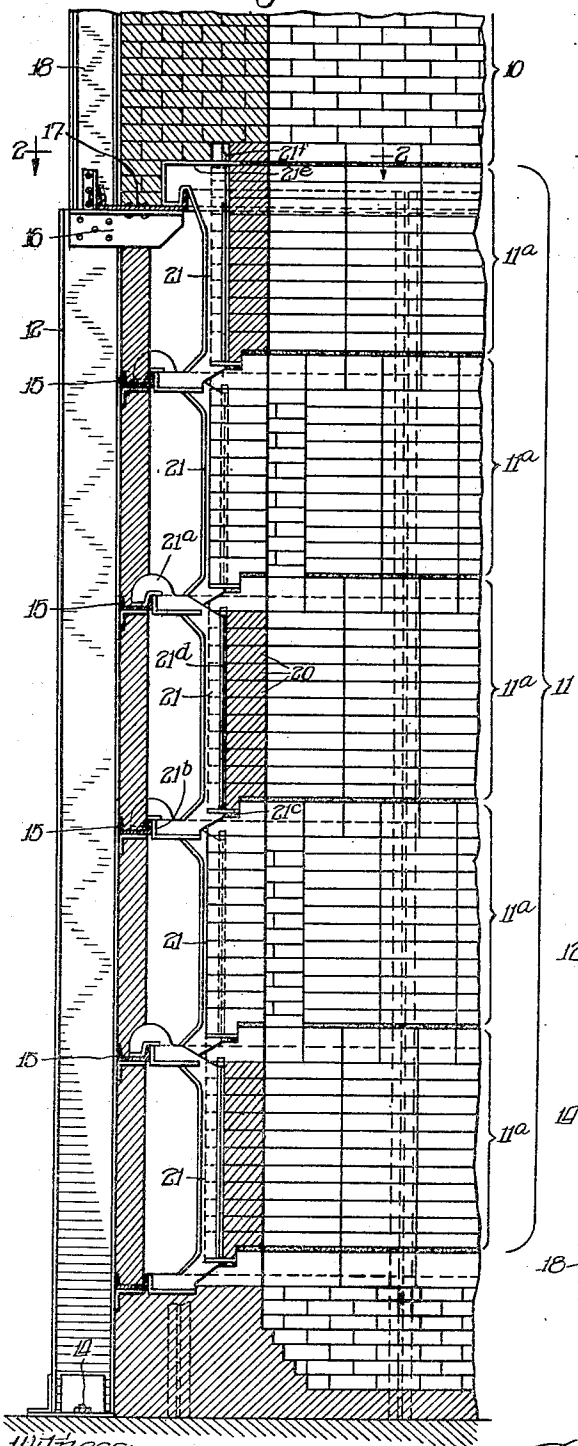
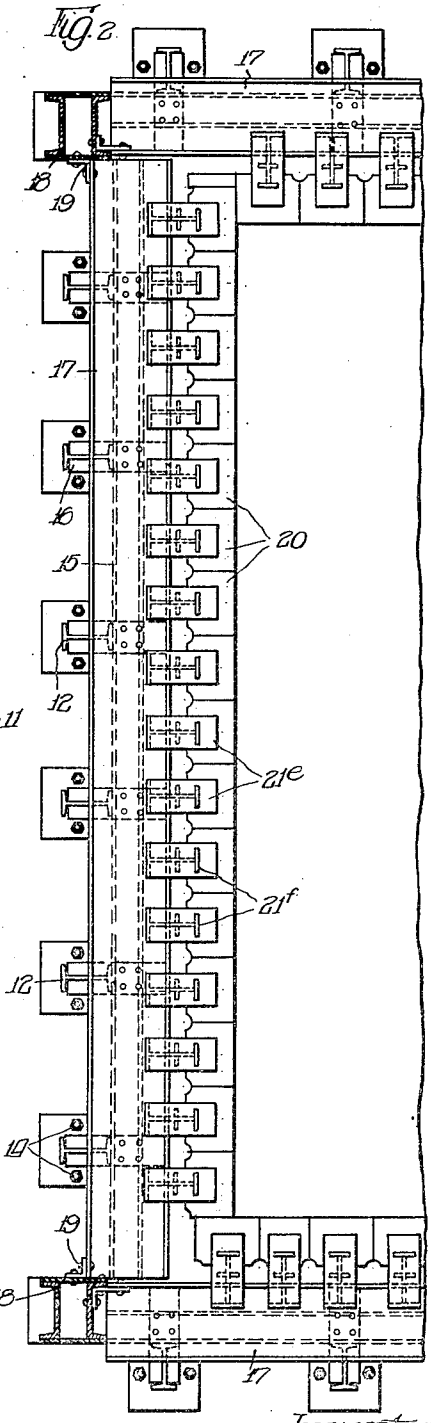


Fig. 2.



Witness:
G. Burkhardt.

By Cromwell, Bentley & Cromwell
Attys

Inventor:
Frank I. Sheahan,

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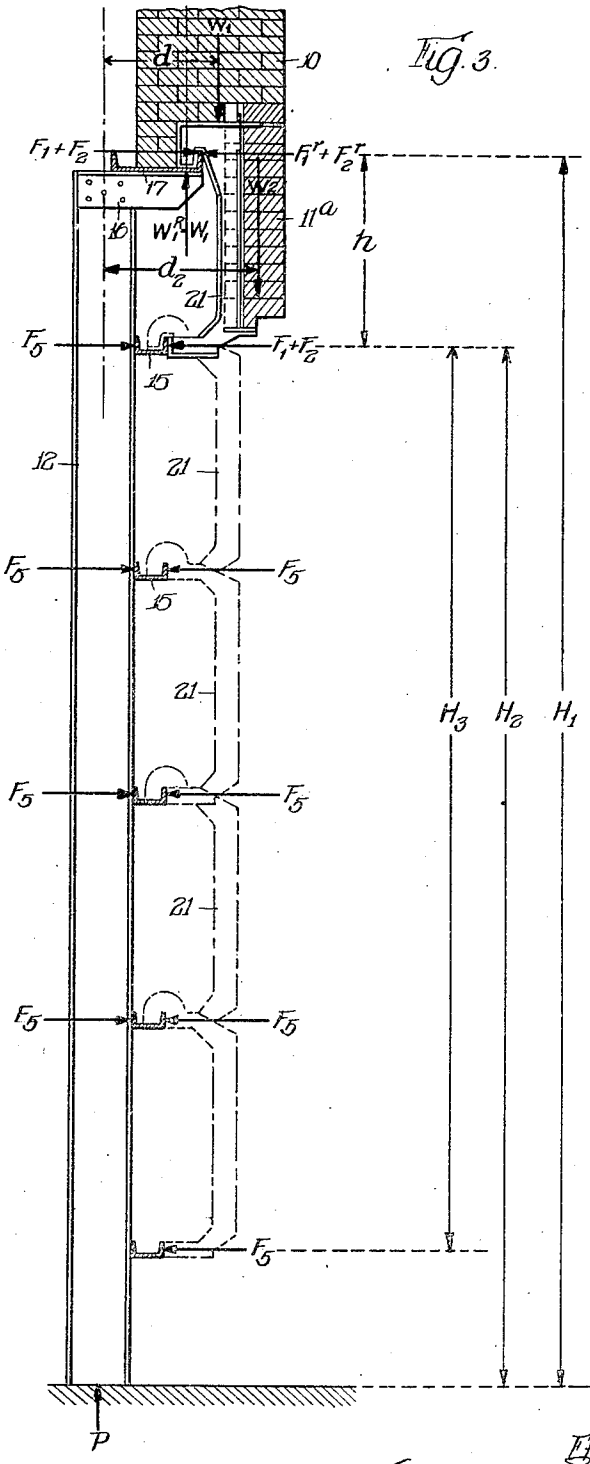


Fig. 3.

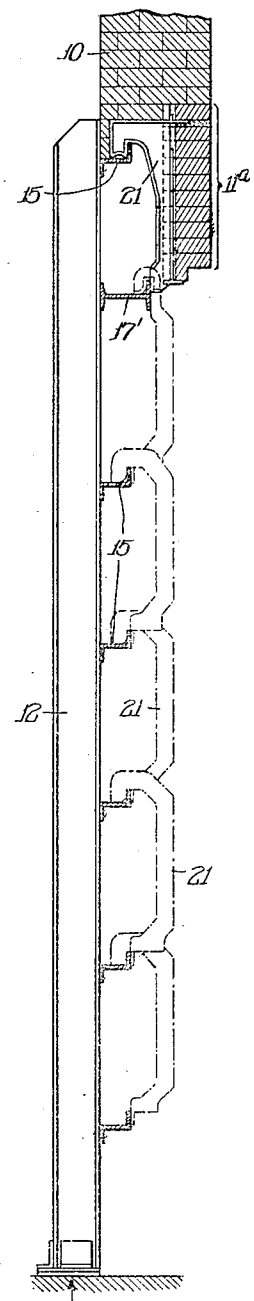


Fig. 4.

Witness:
R. Burkhardt

Inventor:
Frank I. Sheahan,
By Cromwell & Kirkpatrick
Attys.

Patented Oct. 27, 1931 1,829,159

UNITED STATES PATENT OFFICE

FRANK I. SHEAHAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO M. H. DETRICK COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

FURNACE CONSTRUCTION

Application filed December 9, 1927. Serial No. 238,851.

This invention relates to furnace construction and has to do particularly with the construction and support of the furnace walls.

In various kinds of furnaces it is frequently desirable to employ a hollow wall construction in which air chambers or passages are provided between an interior refractory wall and exterior sheathing walls, such passages being utilized for the circulation of air for the purpose of keeping down the temperature of the refractory wall and for pre-heating the air for induction into the furnace. It frequently occurs, as for example in boiler furnaces wherein the boiler is set high above the furnace chamber, that it is necessary to carry a boiler wall on up from the terminus of the combustion chamber wall, for the purpose of enclosing the boiler. Since these boiler walls preferably are built of solid masonry, and frequently are of considerable height, the supporting of them above the hollow wall of the furnace chamber has presented serious difficulties, because of their great weight and the elevation at which they must be supported. In instances, the boiler walls have been supported on heavy steel beams, which in turn are supported on heavy columns at their ends. Such arrangements, however, in addition to involving dis-proportionate expense, because of the large amount of structural steel necessary, involve difficulties in the cooling of the supporting beams and their protection from heat, as well as the effective bracing of them against torsion, and the effective joining up of the furnace wall with the boiler wall.

The present invention involves a construction wherein the furnace wall is of the hollow type suspended in sections on a metallic framework, while the superimposed boiler wall which forms, in effect, an upward continuation from the furnace wall, is likewise carried on the metallic framework, without imposing any weight on the refractories or bricks of the furnace wall.

The general object of the invention is the provision of a construction whereby a heavy boiler wall may be supported above and in conjoining relationship with a suspended furnace wall by a metallic framework requiring a minimum amount of steel and requiring no supplementary bracing in directions transversely of the wall.

Another object is the provision of a construction wherein a suspended furnace wall and a superimposed wall may be supported on a metallic framework, with liberal spacing of the frame members from the refractories which are exposed to the furnace heat, and liberal exposure of the metallic frame members to cooling air, without imposing on the frame members tilting forces, due to eccentric loading, of such magnitude as to necessitate supplemental bracing for supporting them.

Another object is the provision of a construction wherein a superimposed wall may be supported in conjunction with a subjoined suspended wall on columns disposed laterally and exteriorly of the walls, without subjecting the suspended wall to the weight of the superimposed wall.

Other and further objects will be pointed out or indicated hereinafter, or will appear to one skilled in the art upon an understanding of the invention or its employment in practice.

In the accompanying drawings forming a part of this specification I illustrate portions of furnace wall construction embodying the invention, but it is to be understood that these are here presented for the purpose of illustration only, and are not to be accorded any interpretation having the effect of limiting the claims short of the true and most comprehensive scope of the invention in the art. In said drawings

Fig. 1 is a sectional elevation of a wall construction showing portions of two adjoining walls, one shown in sectional elevation and the other in elevation,

Fig. 2 is a cross section taken on substantially line 2—2 of Fig. 1 showing the entire length of one wall and portions of two walls adjoining it at its ends, and

Fig. 3 is a diagram illustrating the loading and turnings forces imposed on the supporting members of the wall frame.

Fig. 4 is a similar diagram of an alternative construction.

These views will serve to illustrate a construction wherein a superimposed wall of solid masonry construction, designated generally by the reference numeral 10, is supported in conjoining relationship with a sectional suspended wall of a furnace chamber, which suspended wall is designated generally by the reference character 11, the construction being appropriate for use in a boiler furnace. It will be understood that the term "wall" as hereinafter used, may apply to any one or all of the sides of the furnace structure. Along the line of the wall are disposed, at appropriate intervals, supporting columns 12 with their radius of maximum stiffness disposed in a direction transversely of the wall. They are anchored at their bottoms to suitable foundation members by connecting means 14, and carry at suitable vertical intervals the sections supporting members 15, which extend longitudinally of the wall and which are here shown as channel members attached to the inner flanges of the column members 12. At their tops, the column members 12 carry the brackets 16 extending inwardly of the wall, and upon these brackets and secured thereto is carried a tie member 17 which functions also as a support for the superimposed wall and the upper section of the suspended wall. This tie member is here illustrated as a channel with its radius of maximum stiffness extending in a direction transversely of the wall. At its ends this tie member is tied to the boiler columns 18, as by the angle pieces 19. Thus, the tie member 17 finds support at proper intervals on the brackets 16 and columns 12, so that it is rendered quite stiff in the vertical direction, and it, in turn, forms a connection between all of the columns 12 which is very stiff in the direction transversely of the wall, and being anchored to the boiler columns at its ends, in addition to holding the columns 12 in alignment, it holds them against tilting inwardly.

The suspended wall 11 is subdivided into a plurality of zones 11*a*, one above another, each made up of a row of collaterally arranged sections. Each section is formed of a stack of refractories 20 supported on a hanger 21. Each hanger has at its upper end a tension arm terminating in a hook 21^a which engages over the inner flange of one of the members 15 or, in the case of the upper row of hangers, the inner flange of the tie member 17, and at its lower end a compression arm terminating in a foot 21^b which bears against the inner flange of the next lower member 15. The refractories on each hanger are supported on a shelf 21^c and anchored to a vertical flange 21^d, which fits in slots in the outer ends of the refractories. The hangers of adjacent zones are arranged in staggered relationship, so that the vertical joints between sections in adjacent zones are broken. With the sections thus supported, the refractories form a continuous refractory wall for the furnace chamber, the refractories in each section being supported independently of those in all other sections, so that the weight or expansion pressure of no section is imposed on another. Expansion space is left between adjacent zones, and filled with a compressible refractory material, to accommodate the expansion of the respective sections. An outer or sheathing wall 22 is supported in sections on the members 15.

The hangers 21 of the uppermost zone are provided at the top with shelves 21^e extending the full length of the compression arm and projecting inwardly beyond the vertical flange 21^d. From the shelf 21^e projects upwardly a short lug 21^f, in line with the flange 21^d. A course of refractories is positioned on the shelves 21^e, finding anchorage by their slots on the lugs 21^f. On this top course of refractories, and on the shelves 21^e and on the web of the tie 17, is supported the superimposed wall 10, which is built up in the customary fashion to the height necessary to enclose the boiler, an expansion space being provided between the course of refractories on the shelves 21^e and the course immediately below it.

By this construction, it will be observed, both the sectional wall and the superimposed wall are carried on the column members 12, but since they are positioned entirely, or almost entirely, inwardly of the column members, or of their neutral vertical axis, it would appear that the column members are subjected to heavy forces tending to tilt them inwardly and necessitating their being braced. By virtue of the construction, however, these apparent tilting forces are to a very substantial extent neutralized, so that the actual resultant is reduced to a value which easily can be supported by the anchorage of the tie members 17 at their ends, and taken by the boiler column quite safely.

The mechanics of the structure is illustrated in Fig. 3. The columns 12 may be regarded as a series of stiff levers fulcrumed at P and rigidly connected at their tops by the tie member 17. The weight W_1 of the superimposed wall on the uppermost row of hangers 21 produces a couple which exercises on the tie member 17 an inward force F_1 which is equal to

$$\frac{W_1 \cdot d}{H_1}$$

and which tends to swing the tie member and the columns inwardly about the fulcrum P of the latter. This couple, acting through the uppermost hangers subjects the columns to an equal outwardly acting force F_1 at the uppermost member 15, which tends to swing

the columns outwardly about their fulcrum point. This outward force F_1 is effective, through the columns, on the tie member 17 as an outward statical moment F_1^r which is equal to

$$\frac{F_1 \cdot H_2}{H_1}.$$

Likewise, the weight of the topmost zone 11^a produces through the uppermost hangers 21 a couple

$$\frac{W_2 \cdot d_2}{h}$$

which exercises on the tie member 17 an inward force F_2, and on the columns at the upper member 15 an equal but outwardly acting force F_2. Each of the lower zones, assuming them to be all of the same weight and height and disposed the same distance from the axis of the columns, subjects the columns to equivalent inward and outward forces F_5 at the respective members 15, which forces cancel each other excepting at the lowermost member 15, where the force is outward. The inwardly acting force F_2 on the tie member is consequently counteracted in part by an outward statical moment F_2^r through the medium of the columns and becomes equal to

$$\frac{F_2 \cdot H_3}{H_1}.$$

The reaction requisite to maintain the tie member in equilibrium is the summative value of the inward and outward forces effective on it. Calling the inward forces positive and the outward forces negative, their summative value is $F_1+F_2-F_1^r-F_2^r$, which value is obviously appreciably less than the aggregate of F_1 and F_2, and can easily be carried by the boiler columns without supplementary bracing. It will be observed that the stiffest axis of the tie member 17 is in the plane of this horizontal force, thus qualifying that member to carry the horizontal forces and reactions without bending and to distribute them equally among all the columns. It will be observed also that in the transmission of these horizontal forces and reactions the columns function as levers fulcrumed at the base. It will be observed also that the bending moment exerted on the columns by the weight of the superimposed wall through the leverage of the brackets 16 is taken by the columns in their plane of greatest stiffness, and due to this fact, together with the fact that the weight is equalized among the columns through the medium of member 17, they are able to carry the eccentrically acting weight of the superimposed wall without having to be excessively heavy themselves.

In addition to effecting a very substantial saving in weight of the frame members by virtue of the features above described, the construction makes it possible to reduce the excess allowance in the weight of steel included as a safety factor against weakening by heating, as all of the steel work is liberally spaced from the heated refractories, with air-circulating space intervening, and with liberal exposure of the steel members to external air. In referring to the steel, I do not wish to be understood as including the hangers 21, as these are cast members, and consequently are not so quickly reduced in tensile strength by heating as is steel. As seen in Fig 2, moreover, in a four-wall construction the tie member 17 of any one of three conjoining walls function as a strut effective to brace the boiler columns against the horizontal forces imparted to them by the tie members of the two adjoining walls.

The construction preserves all of the advantages of the sectional hollow wall including its flexibility, accommodation of expansion, avoidance of heavy loading of refractories, cooling and air pre-heating features, facility of repair, etc., while permitting the building of the superimposed wall as an upward continuation of the suspended wall. The weight of the tie member 17 need be only a small fraction of that required in beams with end support, were such construction to be employed for carrying the superimposed wall. By use of this construction the furnace can be given a finished external appearance, floor space may be conserved, because of the absence of external bracing, and foundation requirements are simplified because of the uniform distribution of the weight of the wall.

In the modified arrangement shown in Fig. 4, the various parts are designated by reference characters as in the other figures, with the exception of the tie member, which is designated 17'. In this arrangement this tie member is secured to the columns 12 at a point below their upper extremities, and is anchored at its ends to the boiler columns, as described in connection with the other embodiment. The upper tier of hangers 21, upon which the superimposed wall 10 is supported, have their compression arms disposed in cooperation with the tie member, so that the horizontal moments exerted on the latter by the weight of the superimposed wall and the topmost suspended sections are in the outward direction. Leaving the effect of the lower sections out of consideration, therefore, the net horizontal thrust which the anchoring connections of the tie member have to carry is represented, as explained above, by the difference between the statical moments of the outward and inward forces on the columns.

What I claim is:

1. In furnace construction, in combination, a furnace chamber wall subdivided into sec-

tions disposed one above another with expansion joints between them, a row of columns ranged alongside the furnace chamber wall, means cooperating with the columns at vertically spaced localities for supporting the respective sections independently thereon, and a superimposed wall supported entirely by the columns and forming an upward continuation from the top of the furnace chamber wall, an expansion joint being provided between the topmost section of the furnace chamber wall and the superimposed wall.

2. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber, a hollow furnace chamber wall supported laterally on the columns, and a superimposed wall supported entirely by the columns above the hollow wall and forming an upward continuation thereof.

3. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber, hangers supported laterally on said columns, a furnace chamber wall supported by said hangers, and a superimposed wall supported entirely by said columns above the furnace chamber wall, said superimposed wall resting in part on certain of said hangers, and an expansion joint being provided between the furnace chamber wall and said superimposed wall.

4. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber, a tie member running longitudinally with the wall and rigidly connecting said columns adjacent their upper ends, means anchoring said tie member at its ends against shifting inwardly or outwardly of the furnace chamber, a furnace chamber wall portion disposed laterally of the columns, a superimposed wall supported entirely by the columns and forming an upward continuation from the top of the furnace chamber wall.

5. In furnace construction, a row of columns ranged alongside the furnace chamber, a tie member connecting the columns adjacent their upper ends to hold them in the desired alignment, anchoring means at the ends of the tie member holding it against shifting transversely, a hollow furnace chamber wall supported on the columns and disposed laterally thereof, and a superimposed wall supported entirely by the columns and forming a top closure for and an upward continuation from the furnace chamber wall.

6. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber and anchored at their lower ends, a tie member connecting the columns adjacent their upper ends to hold them in the desired alignment, means anchoring the tie member at its ends to hold it and the columns against swinging laterally, hangers extending laterally from the columns, a furnace chamber wall supported on said hangers, and a superimposed wall resting partly on certain of said hangers and carried entirely by the columns in a position above the furnace chamber walls.

7. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber and anchored at their lower ends, a tie member rigidly connecting the columns adjacent their upper ends and anchored at its ends against shifting transversely, a row of hangers disposed laterally of the columns and connected therewith at vertically spaced localities, refractories supported on said hangers to form a furnace wall portion, and a superimposed wall supported on certain of said hangers above said furnace wall portion, whereby the weight of said superimposed wall is transmitted to the columns through said hangers independently of the furnace wall.

8. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber and anchored at their lower ends, a tie member connecting the columns adjacent their upper ends whereby to hold them in alignment, means anchoring said tie member at its ends to hold it and the columns against moving laterally, said tie member extending laterally from the columns and having its radius of maximum stiffness disposed horizontally, wall supports connected at their upper ends to said tie member, means for transmitting outward thrusts to the columns from the lower ends of said wall supports, and a wall portion supported entirely on the columns through the medium of said tie member and certain of the wall supports.

9. In furnace construction, in combination, a row of columns ranged alongside the furnace chamber and having their radius of maximum stiffness directed toward the furnace chamber, transverse members connecting the columns and extending laterally thereof, hangers supported in tension on one of said transverse members and bearing in compression against a lower transverse member, means anchoring one of said transverse members at its ends to hold it and the columns against swinging laterally, a wall section supported by said hangers laterally of the columns, and a superimposed wall supported by said hangers and disposed laterally of said columns, whereby the entire weight of said superimposed wall is transmitted to said columns as a couple.

10. In a boiler furnace, in combination, a row of columns ranged alongside the furnace chamber, a tie member connecting the columns adjacent their upper ends, boiler columns at the ends of the tie member, means anchoring the tie member to the boiler columns to hold the tie member against shifting laterally, hangers supported by the columns and disposed laterally thereof, a furnace chamber wall carried in sections on the hang-

ers, and a boiler wall supported entirely on certain of the hangers and columns independently of the furnace chamber wall, said hangers cooperating with the tie member and columns to transmit their loading to the latter as a couple.

11. In a boiler furnace, the combination with the boiler columns, of wall supporting columns ranged along the sides of the furnace chamber, tie members connecting the wall columns on the respective sides of the furnace adjacent their upper ends, said tie members anchored at their ends to the boiler columns and forming spacing struts between the boiler columns, furnace walls suspended on the wall columns at their inner sides, and boiler walls supported on the wall columns and forming upward continuations of the furnace walls.

12. In furnace construction, in combination, columns ranged along the furnace chamber and fulcrumed at their lower ends, a tie member connected to the columns adjacent their upper ends, means anchoring the tie member at its ends to hold it against shifting transversely, hangers disposed inwardly from the row of columns, suspended wall sections carried by the hangers laterally of the columns, a superimposed wall supported by certain of the hangers above the suspended wall sections, and connections between the hangers and columns whereby the loading carried by the hangers is transmitted to the columns as a couple.

In testimony whereof I have hereunto subscribed my name.

FRANK I. SHEAHAN.