

May 16, 1939.

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2,158,759

FURNACE ROOF CONSTRUCTION

Filed Sept. 21, 1937

3 Sheets-Sheet 1

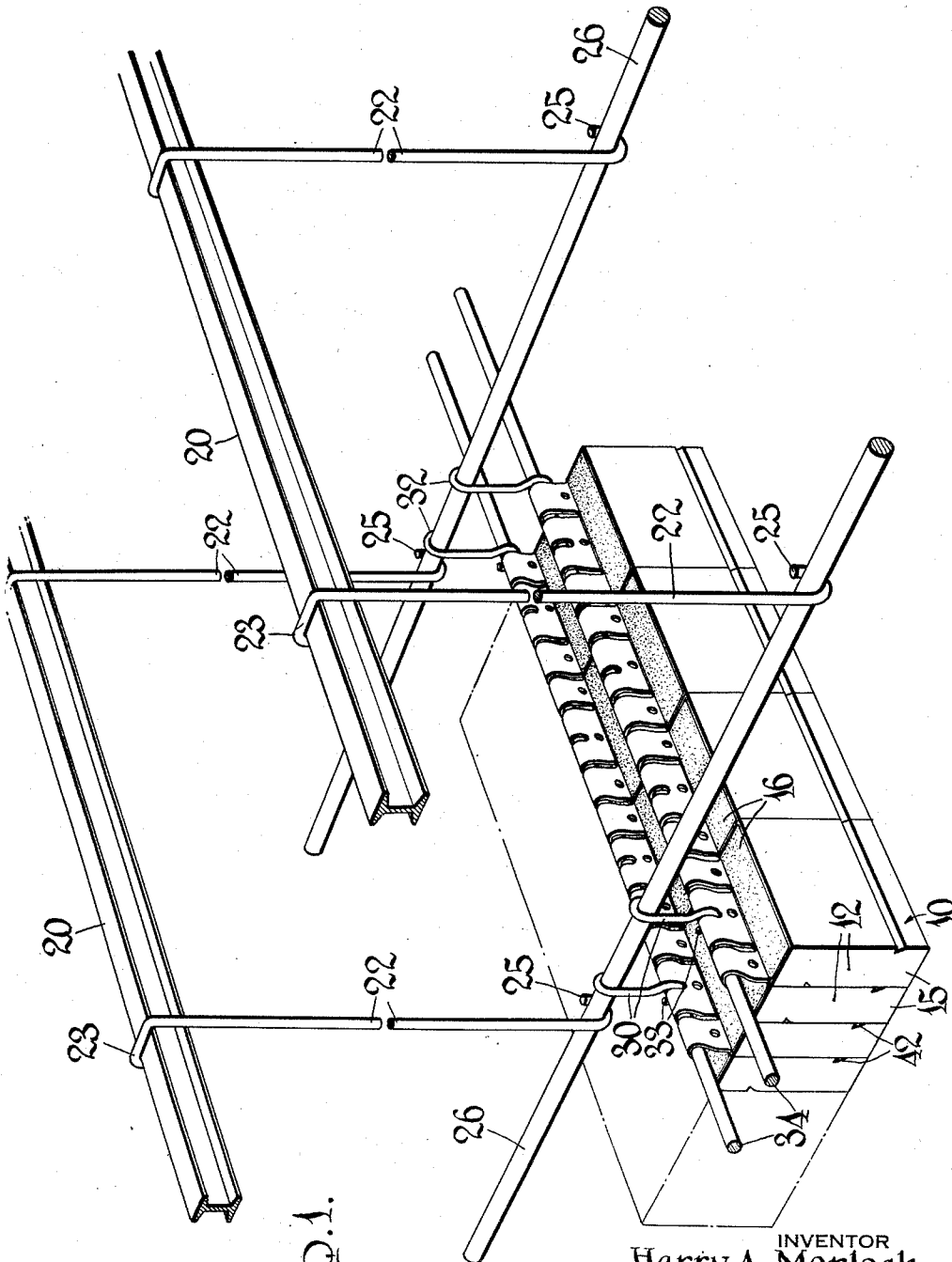


FIG. 1.

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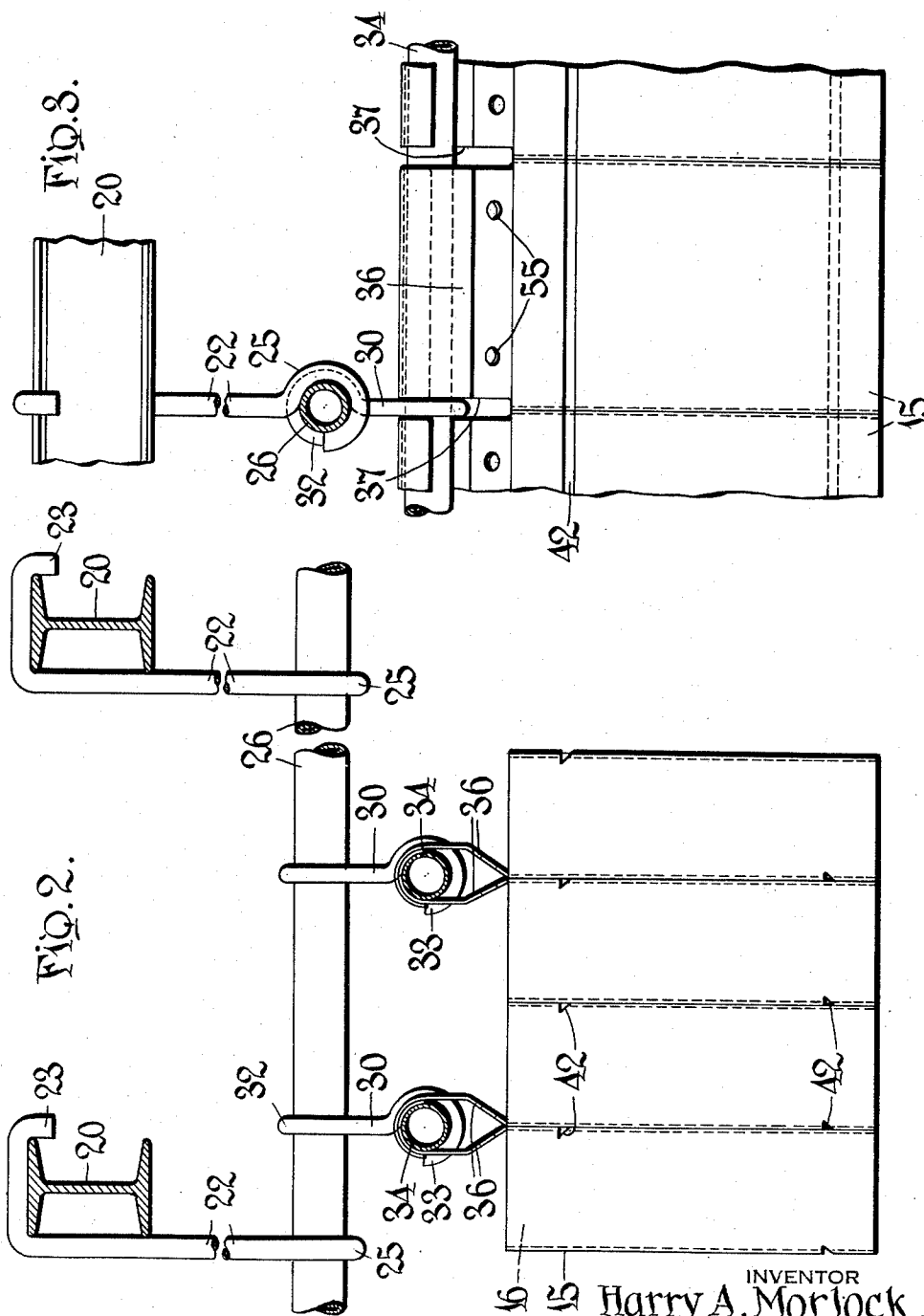
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3 Sheets-Sheet 2



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FIG. 8.

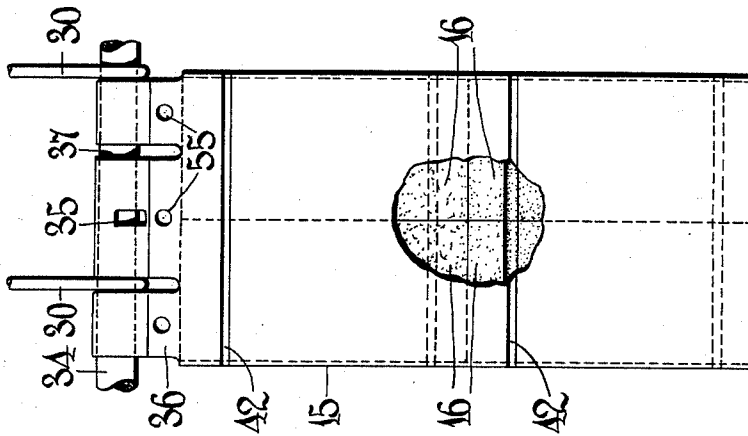


FIG. 6.

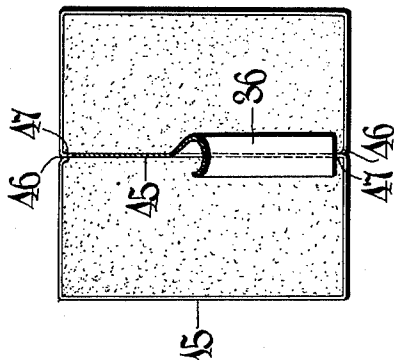


FIG. 7.

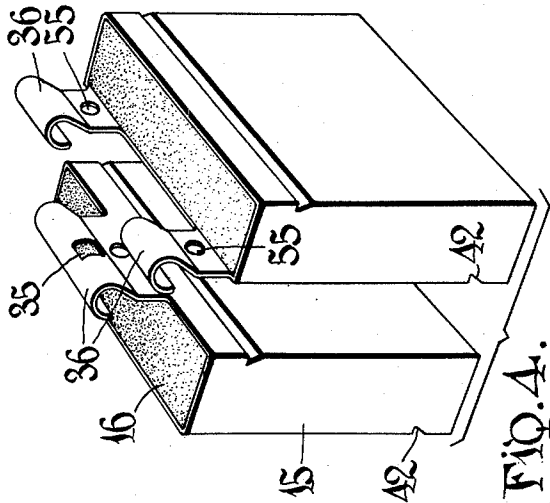
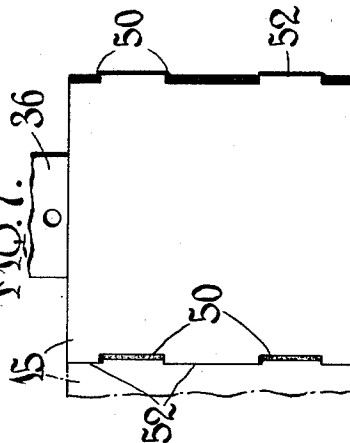
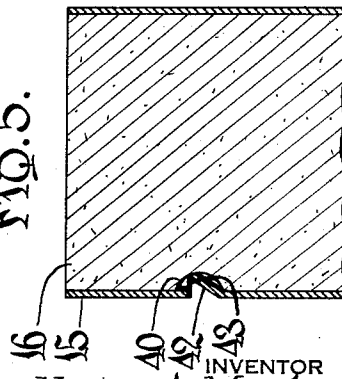


FIG. 4.

FIG. 5.



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FURNACE ROOF CONSTRUCTION

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Application September 21, 1937, Serial No. 164,897

5 Claims. (Cl. 110—99)

This invention relates to roof or arch structure for furnaces and it has particular relation to arrangement of roof refractories, together with their suspension members.

5 One object of the invention is to provide in a roof construction an improved arrangement that will maintain the refractory elements in proper position and will prevent spalls from falling therefrom.

10 Another object of the invention is to provide in a roof structure improved arrangement of suspension members which facilitate proper placing of the refractories and insuring access to the roof for inspection and repair after installation.

15 Another object of the invention is to provide an improved construction of canister for retaining and suspending refractories in furnace roof construction.

20 Another object of the invention is to provide supporting structure which reduces to a minimum the number of suspension elements for supporting the several refractory elements of which the roof is composed.

25 Another object of the invention is to provide an improved furnace roof construction in which basic refractories are so arranged as to serve efficiently for arch construction.

30 The invention is universally applicable to furnaces of various types in which solid, gaseous or liquid fuel are used for combustion or to furnaces wherein heat is conveyed from such fuels by radiation or convection. Likewise, the invention is applicable to various types of electric arc and resistor furnaces.

35 The refractory components of such an arch have distinct chemical and physical properties and certain refractories of desirable chemical properties are not available for specific indicated applications due to the structural limitations or weak physical properties.

40 Refractories can be divided chemically into two great classes, i. e.: basic and acid. As is well known in metallurgy, it is a law that acid materials will act as a flux for basic materials and tend to combine to form a compound having a melting point below that of either single constituent.

45 The most intensely acid refractory is silica brick, which, in accepted refractory parlance, indicates a brick of silicon dioxide content of more than ninety percent. Fire-clay brick containing a lesser amount of silicon dioxide, the latter having been in part replaced by aluminum
55 oxide or alumina, are acid in their chemical be-

haviour toward basic fluxes, but to a lesser degree than is silica brick.

The most widely used basic refractories are those composed of magnesite (magnesium oxide), dolomite (calcium-magnesium oxide), chromite (natural iron-chromate or chrome ore) or combinations of these materials.

The acid refractories possess the highest degree of compressive strength at elevated temperatures, this compressive strength being increased as their acidity or content of silica is increased. It is further true that acid refractories follow a ratio of temperature increase to volume increase wherein small temperature changes bring small volume changes excepting in the higher silica content refractories. In this latter class small temperature changes bring large volume increases up to a certain well known range at the beginning of which range all volume increase practically ceases.

20 The basic refractories possess a much lower compressive strength at elevated temperatures and will crack or shear under conditions of load and temperature of lower value than will the acid refractories.

25 The basic refractories follow a ratio of temperature increase to volume increase wherein every temperature increase brings a volume increase. The bulk density of the basic refractories is also in cases nearly double that of the acid refractories.

30 By reason of the high compressive stress in sprung or compression arches, the acid refractories have heretofore been used because of their greater carrying characteristic at high temperature.

35 In conducting certain melting, smelting or heating processes, there are present in the furnace interior basic liquid or basic solid particles emanating from the charge or fuel which tend to flux the refractories forming the roof. The fluxing induces a chemical change in the refractories, lowering their fusion point and other physical properties, thus producing early failure. Hence, to resist the destructive chemical attack of the gaseous, liquid or solid particles, a roof or arch of basic refractory materials is required.

40 The following are types of the fluxes before mentioned: (a) lime fume from high calcium slags, (b) molten metals or their oxides which are splashed onto the under-surface of the arch during certain phases of metallurgical processing, (c) dusts which arise from furnace charges of processed contents.

45 The compressive stress in a sprung arch is a direct function of the weight of the radial re-
55

fractory components of such an arch. By reason of the increased weight of basic refractories in arches constructed therefrom, the stress generated therein is greater than with acid refractories and further, by reason of the weakness or low, hot-load carrying physical properties, these basic refractories fall prematurely.

It should be understood that in sprung or compressive arches cracking or fracturing of the refractories can and often does take place along lines substantially concentric with the surfaces of the arch. The fragments or spalls resulting from such cracking or shearing, however, are largely held in place by the compressive action of unfractured adjacent tile and no loss of effective refractory thickness is suffered.

It should also be understood that dusts or other foreign matter, if allowed to accumulate in locations on the upper surface of the arch or roof, will by their thermal insulating effect, cause localized overheating and the dust covered location will suffer accelerated fluxing with possible complete failure through burning out. Such localized heating will also cause localized stress which may result in other forms of physical failure of the arch. Hence, it is necessary that the upper surface of the arch be accessible for ready removal of such deposits of dust or foreign matter. The arch must also be accessible for inspection so that failure which might result in human hazard or product loss may be guarded against.

Under those conditions where a roof or arch of basic refractory material is required it has been necessary (a) to support the tile or multiples thereof externally to eliminate the compressive stress, (b) to provide for the retention of the many fragments resulting from the fracture of these weaker refractories by some means other than compression to retain effective refractory thickness. Such suspended arches must insure easy freedom of movement to compensate for the increased dimensions of the structure after thermal expansion has taken place. Any binding or restriction, either longitudinally or transversely will set up stresses resulting in fracture of the roof.

In previously known types of wall or roof construction iron or steel plates were placed in the joints between adjacent basic refractory tile. These plates oxidized, formed compounds with the adjacent tile and were absorbed into the surfaces, thus welding the brick structure into a virtually monolithic mass. When such plates were placed in the vertical or nearly vertical joints between externally supported tile they tended to retain the fragments resulting from shear through thermal shock.

After a period of operation, however, the compounds formed by the combination of the metal plate oxide and the refractory, tended to undergo crystalline growth. Such crystalline growth was accompanied by an increase in volume and the movement generated thereby, meeting great resistance from the weight of the structure, set up stress, tending to displace or buckle sections of the roof with fracture resulting therefrom. Hence, it was necessary to provide large expansion tolerance spaces in constructing basic refractory metal joint structures and often these spaces remained open after the initial thermal expansion of the furnace had been reached until crystalline growth sealed them entirely. While open, these spaces presented avenues of thermal loss from disturbed combustion through air in-

filtration and became clogged with fusible accretions which destroyed their utility as crystalline growth, expansion allowance spaces. The most practical way to reduce the crystalline growth is by reducing the metal plate in the joint where possible to one smallest thickness in cases where furnaces are to be operated for long periods of time.

Hitherto the metal plate has only been considered as a joint sealing device and the tile have been externally supported by metal castings or other metal parts engaging pockets or protuberances in the brick. This has resulted in a multiplicity of suspending rods or other media being required which makes the upper surface of the furnace arch less accessible for cleaning, inspection and repair.

It is further well known that by reason of the temperature volume instability of basic refractories, tile made therefrom should have the highest degree of uniformity in volume distribution throughout its mass. Pockets or protuberances cause relatively large and small volumes to be connected by sections of relatively small cross-sectional area presenting possibility of fracture at points of the tile most vitally situated in the suspending system.

In order to attain the best physical stability in basic refractory tiles, the density of the refractory mass throughout the tile should be as uniform as can possibly be secured. If lack of uniform density exists in a tile, a stress will be set up between non-uniform sections with fracture usually resulting. As basic refractory tile of the most desirable physical properties is best produced by applying high pressures to the tile during moulding or pressing, it is necessary that a tile be designed with a minimum of indentations, protuberances or other surface modifications.

This invention is primarily directed to the provision of brick or tile refractories, particularly the type of basic refractories referred to above which are uniform in all respects, and are provided with a suspension system particularly designed to prevent the disadvantageous features referred to above, as well as to provide improved containers and arrangements thereof for carrying the refractories in combination therewith.

In the drawings:

Fig. 1 is a fragmentary perspective of suspension members and roof for a furnace;

Fig. 2 is a fragmentary elevation of refractory roof elements and suspension elements for a furnace and with portions of the suspension members shown in cross section;

Fig. 3 is a fragmentary elevation of the structure shown in Fig. 2 as viewed at right angles to the structure shown in the latter figure;

Fig. 4 is a perspective of a pair of jackets or canisters for receiving brick or tile employed in refractory furnace roof structure;

Fig. 5 is a fragmentary vertical section of one of the canisters shown in Fig. 4;

Fig. 6 is a plan of a double canister composed of one sheet of material, and having a portion broken away and shown in cross section;

Fig. 7 is a side elevation of another form of canister having partially open sides; and

Fig. 8 is a side elevation of a canister for containing a plurality of refractory members.

In one form of the invention a furnace roof comprises a series of refractory members, each including a canister containing one or more brick or tile which can be composed of suitable basic refractory material of the type re-

ferred to above. Supporting beams 20 carried in a conventional manner (not shown) are provided with suspension members 22 having upper hooks 23 engaging the beams 20 and lower hooks 25 supporting substantially horizontal rods or tubes 26. Spaced hangers 30 are provided with upper hooks 32 engaging the rods 26 and lower hooks 33 likewise engaging and supporting lower rods 34 that are arranged transversely of and below the rods 26. The lower hooks 33 extend through openings 35 formed in flanges 36 that are shaped at their upper portions into hooked form and constitute extensions of the canister wall structure for suspending the canisters from the rods 34.

The flanges 36 of the canisters can be so formed that opposed edges of adjacent canisters provide spaces or recesses 37 into which the lower hooks 33 of the hangers 30 extend to engage the lower rod 34, instead of extending directly through the openings 35 in the body of the flanges.

In the arrangement shown in Figs. 1 to 4, all of the flanges 36 are hooked in the same direction and a double row of canisters 15 can be suspended from a single rod 34 in such manner that all of the hooked flanges along one of the rods 34 are disposed in a single row. One of the canisters of the double row has a pair of spaced hooked flanges 36 (Figs. 1 and 4) and a companion or facing canister of the double row below the same portion of the rod 34 has a single hooked flange 36 disposed between the latter pair of flanges. Therefore, the suspension elements 22 and hangers 30 can be suitably spaced along the rods 26. The upper portion of the roof construction is thus rendered conveniently accessible for repair and inspection, and it is to be understood that the suspension members 22, the rods 26, 34, the hangers 30, and the flanges 36 are so termed for convenience in differentiating these elements and that they all, in fact, constitute suspension members for the refractory containing canisters.

In order to insure proper assembly of the brick or tile 16 and canister, opposite sides of each brick are provided with transverse grooves or recesses 40 into which a pressed out portion 42, formed from the body of the canister wall, is pressed or otherwise forced. Thus the brick and canister are firmly secured together and can be handled as a unitary refractory element, as well as transported, without danger of disassembly. In one satisfactory method of providing this arrangement, the body of the canister 15 can be slit, as indicated at 43, and the pressed out portion 42 can be in the form of a flange which extends upwardly at an incline. Hence, any tendency of the brick to fall from the canister binds the flange more firmly into the groove and enhances the connection between the brick and canister.

In the form of structure shown in Figs. 2 and 3, the canisters 15 are arranged in substantially the same manner as that previously described, but the flanges 36 are hooked over the rods 34 in opposed relation, and one hook can be overlapped with respect to the flange hook of the companion canister. Spaces corresponding to the spaces 37 of Fig. 1 and indicated accordingly, can be provided for the purpose of extending the lower hooks 33 of the hangers therethrough incidental to engagement of the latter with the rod 34. Likewise, openings corresponding to the openings 35 can be provided for this purpose.

Referring to Fig. 6, a double canister 15 so formed as to have double capacity for brick, and is formed of a single sheet of metal bent to provide a central partition 45 between two brick 16 disposed therein. Vertical edge portions 46 of walls of the canister are welded, fused, or otherwise connected with opposite extremities of the central partition 45. In this arrangement a single hooked flange 36 is employed for suspending the double canister upon the rod 34 and sufficient spaces at the edges of the flange 36 are provided, as indicated at 47, to insure proper disposition of the lower ends of the hangers 30 between the flanges of adjacent canisters in the connection of these ends to the rods 34. This type of canister reduces the metal in one third of the joints by approximately 50 per cent, and thus minimizes crystalline growth.

In Fig. 7 sides of the canister 15 are provided with spaced openings 50 which are alternately arranged with respect to similar or symmetrically spaced openings in an adjacent canister. Thus adjacent wall sections 52 between wall openings of one canister fit into openings of the adjacent canister. Thus a single thickness of substantially continuous metal is provided in the joints between the bricks, and thus crystalline growth is minimized without affecting the efficiency of the structure. Otherwise the canister construction is similar to that previously described and corresponding reference characters are employed to designate similar parts.

In the form of structure shown in Fig. 8, the canister 15 is of such size as to receive a plurality of brick 16. The hooked flanges 36 for suspending the canister can be arranged in the same manner as that shown in Figs. 1 and 4, or as shown in Fig. 2. Corresponding elements of the suspension system are substantially the same as those previously described.

In all of the forms of construction described, openings 55 are provided at suitable intervals in the suspension flanges 36 and conventional hoisting tackle can be engaged in these openings to lower the canisters into their proper position in the roof or to lift them therefrom.

From this description it will be apparent that the several forms of construction shown provide for application of the invention to various types of furnaces, as well as to various arrangements of refractory elements and suspension system.

Although only the preferred forms of the invention have been shown and described in detail, it will be apparent to those skilled in the art that the invention is not so limited but that various changes can be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. In a furnace roof construction, a plurality of rows of metallic canisters containing refractory elements, supporting structure disposed above the canisters, adjacent rows of canisters having thereon suspension elements substantially aligned with one another, and said supporting structure having means engaging the aligned suspension elements to support plural rows of canisters along a single suspension row of aligned suspension elements.

2. In a furnace roof construction, a unit of two rows of sheet metal canisters containing refractory elements, canisters of one row having hook flanges extending upwardly therefrom, the canisters of the other row having hook flanges extending upwardly therefrom, edges of said flanges

in both rows being aligned lengthwise of the rows and the edges of each flange being disposed in opposed relation to adjacent flange edges, and supporting means disposed above the canisters and carrying the hook flanges in their aligned relation.

3. In a furnace roof construction, a pair of canisters having refractory elements therein, each canister having a wall portion extended into the form of a hooked suspension member, a side wall portion of one canister being arranged in opposed contacting relation with a side wall portion of the other canister, the hooked suspension member of one canister engaging in overlapped relation the hooked suspension member of the other canister, and supporting structure disposed above the canisters and engaging the suspension members for supporting the canisters.

4. In a furnace roof construction, a unit of two rows of sheet metal canisters containing refractory elements, canisters of each row having upwardly extending suspension flanges, the flanges of the canisters being cut away to provide flange portions of one row of canisters substantially

fitting with flange portions of the other row of canisters, said flange portions being arranged in substantially aligned relation with portions of all the flanges being disposed in substantially the same plane, and supporting structure disposed above the canisters and carrying the flanges in their aligned relation for supporting the canisters.

5. In a furnace roof construction, a unit of two rows of sheet metal canisters containing refractory elements, canisters of each row having upwardly extending suspension flanges, the flanges of the canisters being cut away to provide flange portions of one row of canisters interfitting with flange portions of the other row of canisters, said flanged portions being arranged in substantially aligned relation with portions of all the flanges being disposed in substantially the same plane, a plurality of the flange portions being spaced, and supporting structure disposed above the canisters and carrying the flanges in their aligned relation for supporting the canisters, portions of the supporting structure extending between spaced flange portions.

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