United States Patent

[11] 3,589,316

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[45] Patented June 29, 1971

[54] PANELIZED SUSPENDED ROOF FOR REVERBERATORY FURNACE
17 Claims, 29 Drawing Figs.

[52] U.S. Cl. 110/99
[51] Int. Cl. F23m 5/02
[50] Field of Search 110/99, 180

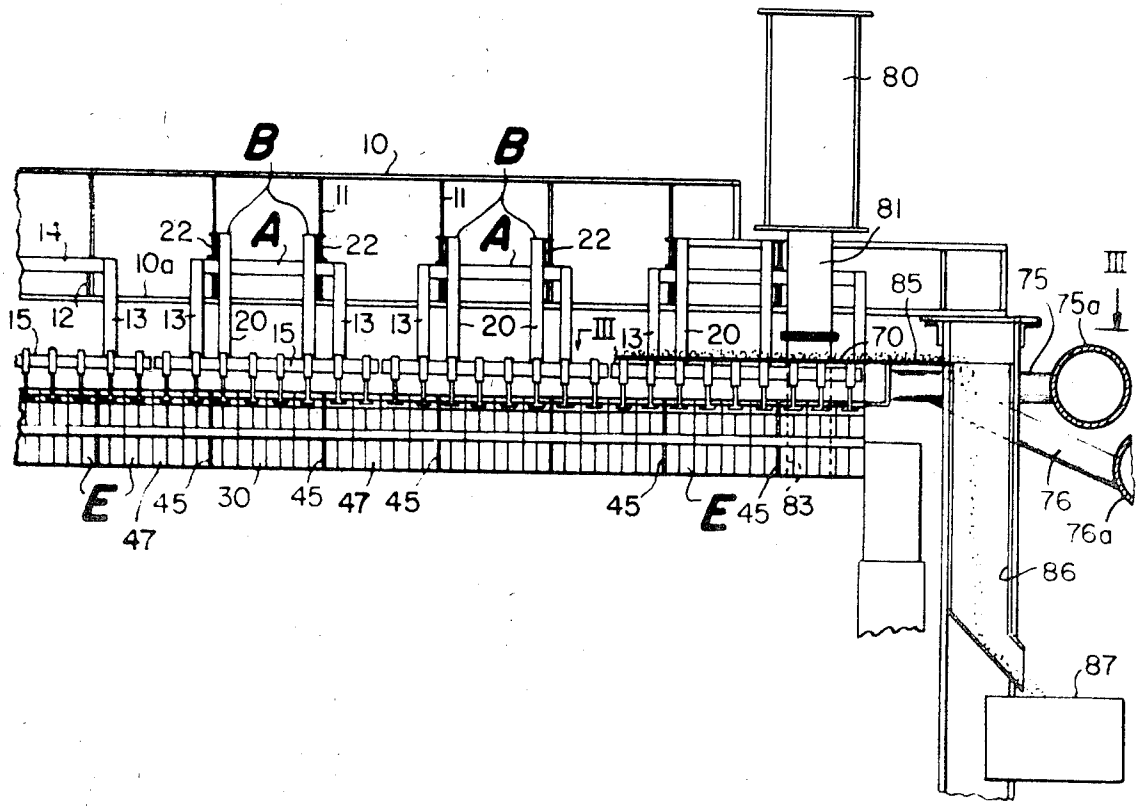
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Primary Examiner—Edward G. Favors
Attorney—Green, McCallister and Miller

ABSTRACT: A furnace roof of basic or magnesite-chrome refractory tile is provided whose members are assembled in banded bundles and are carried by overhead metal panel frames or sections of two types, one called a primary type is cantilevered from an associated I-beam and the other called a secondary type is suspended or cantilevered or piggy-back mounted on a pair of longitudinally spaced-apart panels of the first type. Tile of the bundles are metal-clad in an improved manner as a bundle and for hot patching are provided with a sandwich or assembly of asbestos and metal plate members. Upper reaches of the tile members are sealed-off from charging spillage and dust that may be recovered for use in the furnace; air cooling is facilitated.



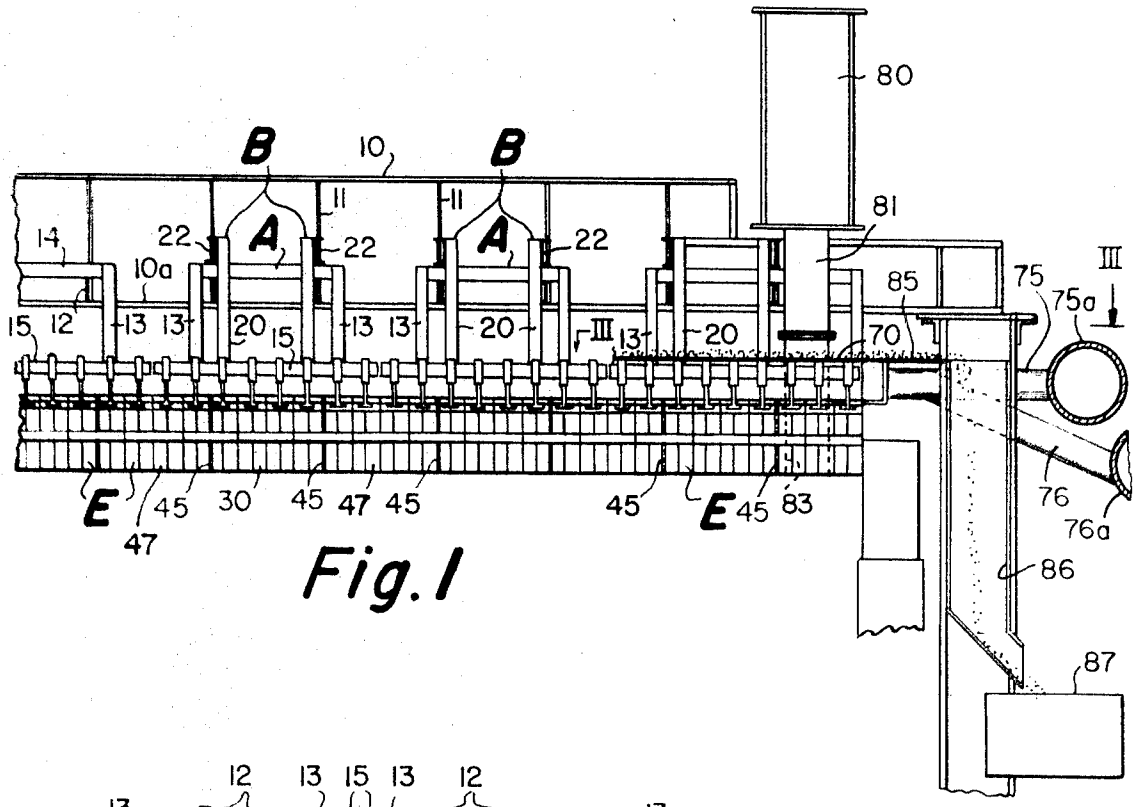


Fig. 1

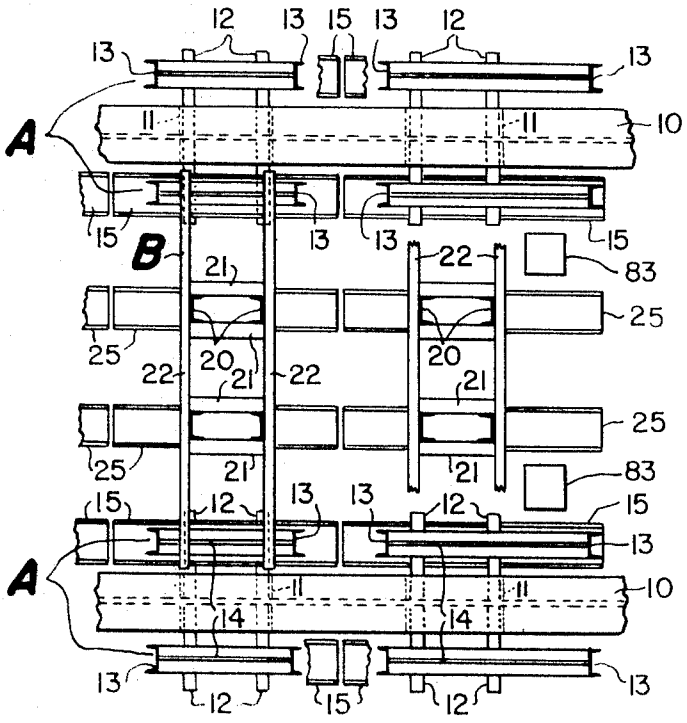


Fig. 2

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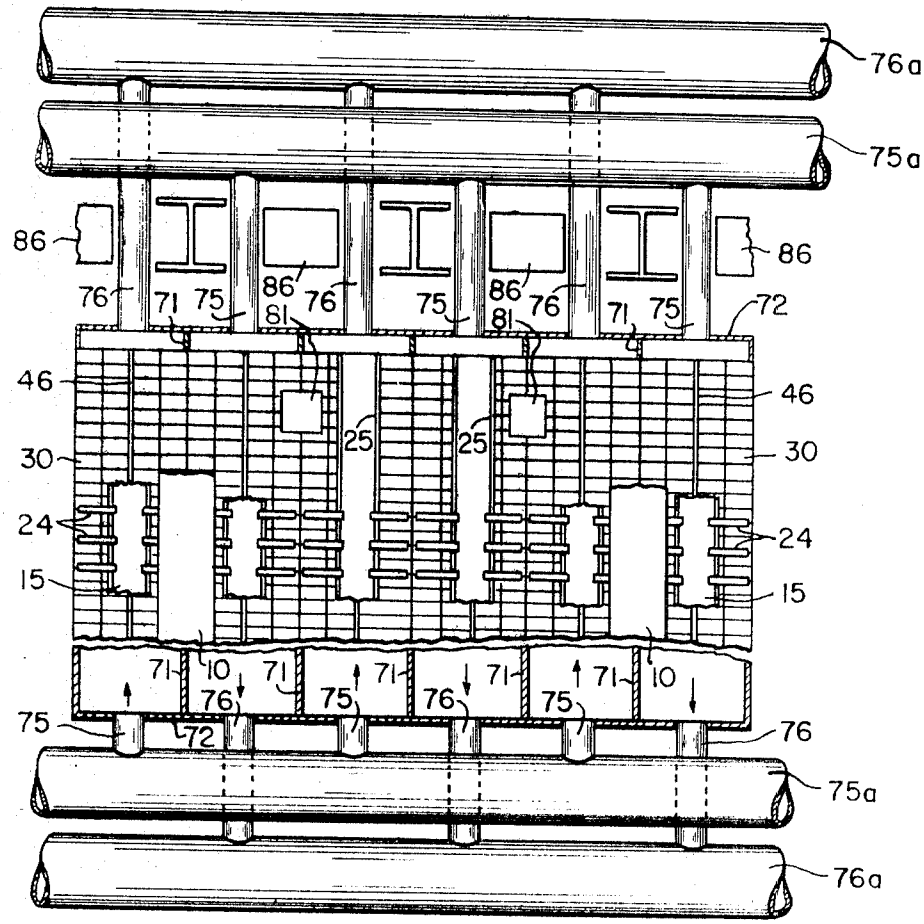


Fig. 3

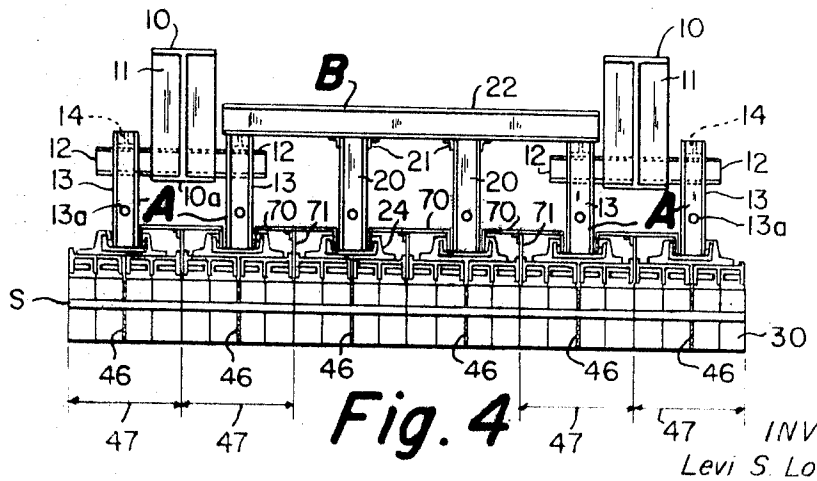


Fig. 4

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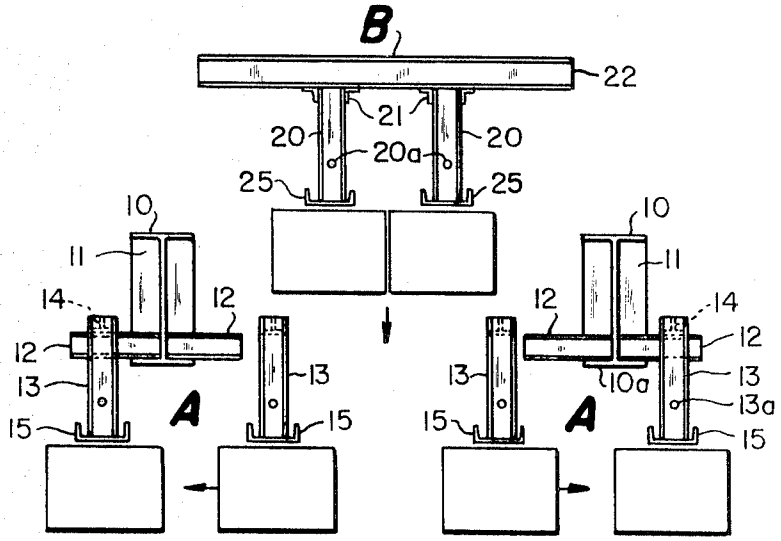


Fig. 5

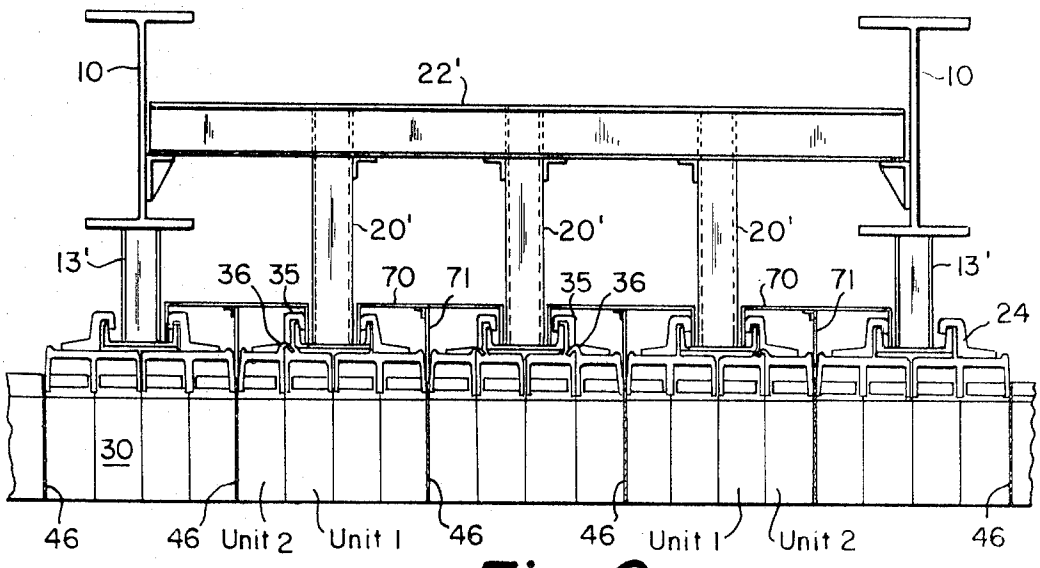


Fig. 6

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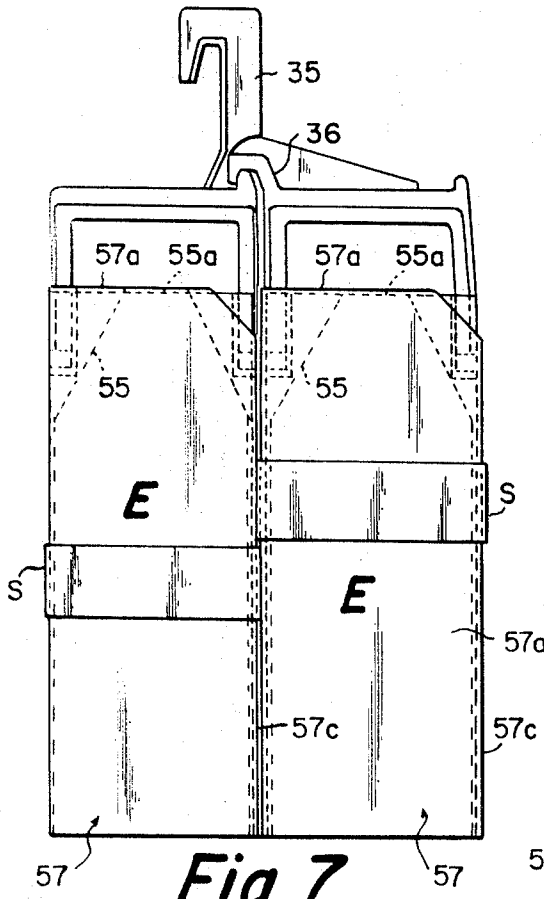


Fig. 7

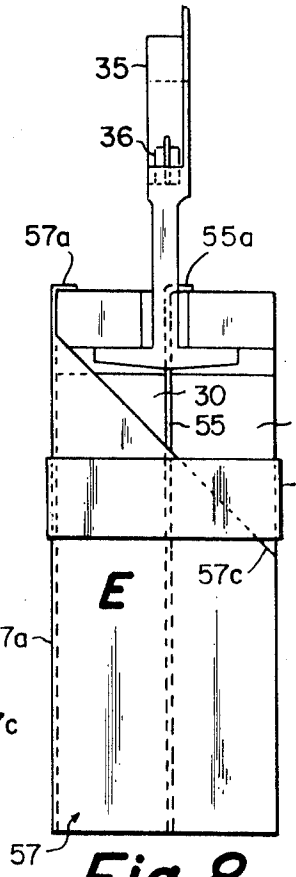


Fig. 8

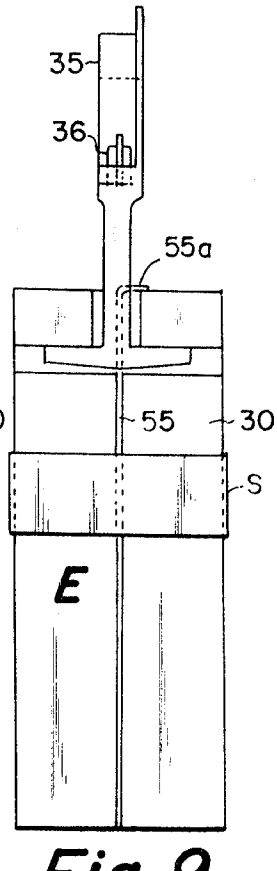


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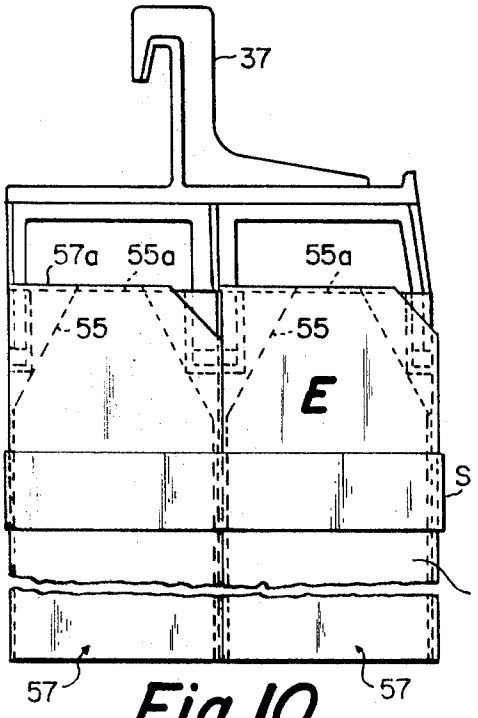


Fig. 10

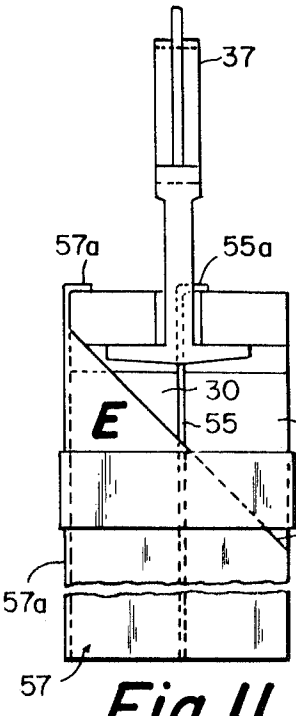


Fig. 11

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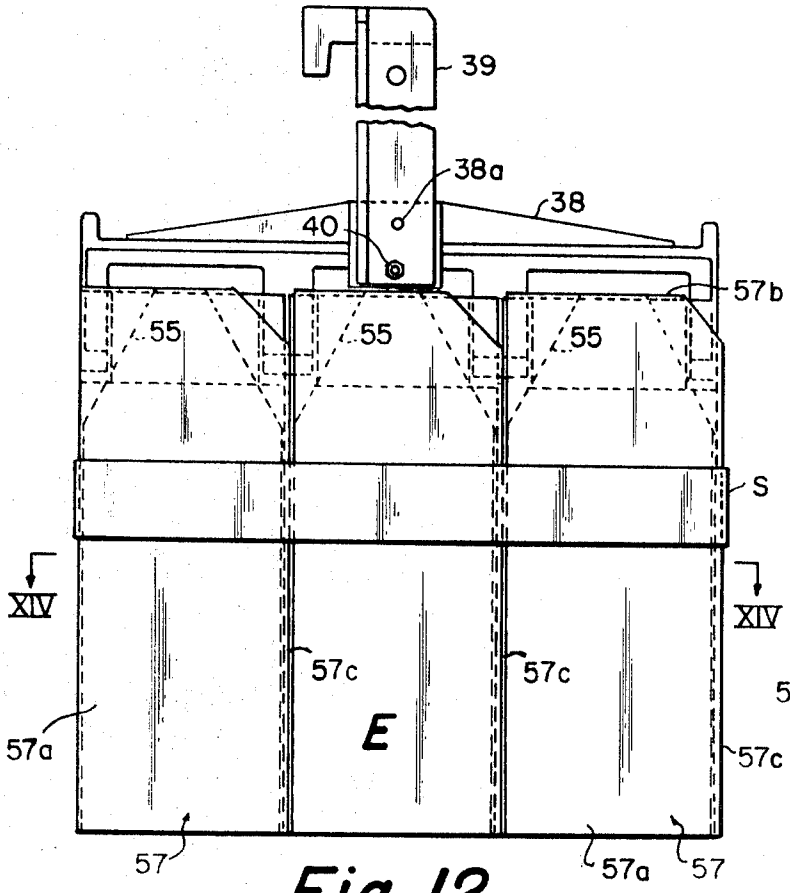


Fig. 12

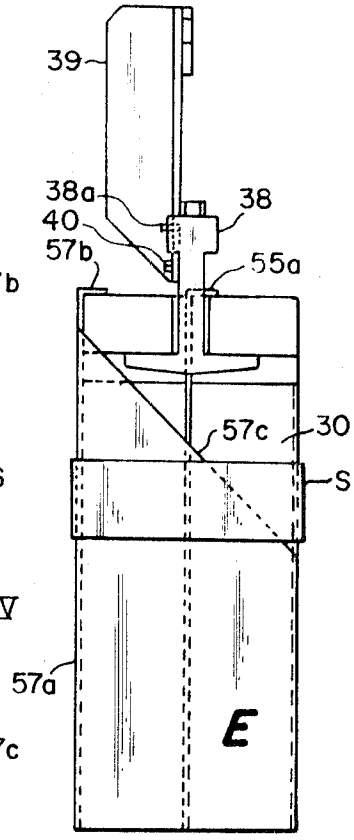


Fig. 13

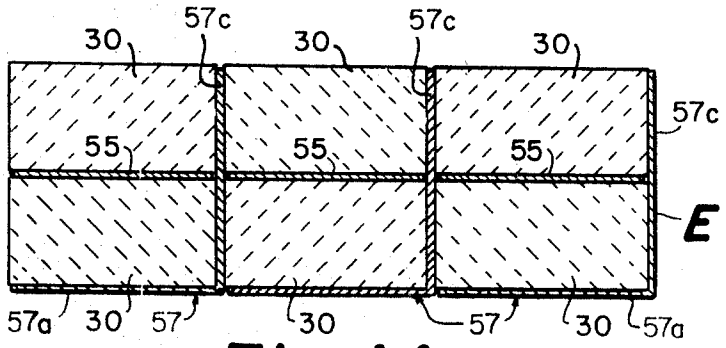


Fig. 14

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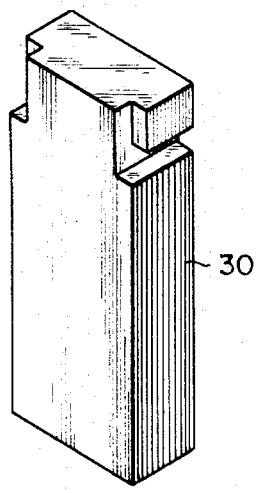


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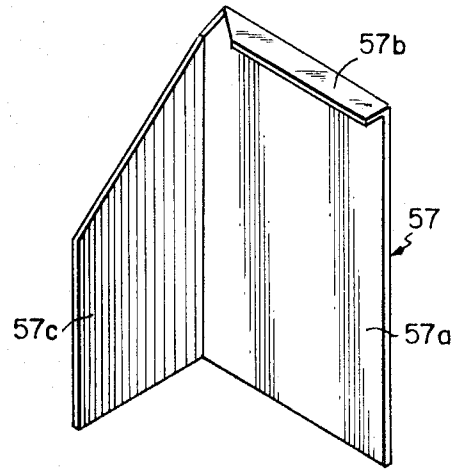


Fig. 16

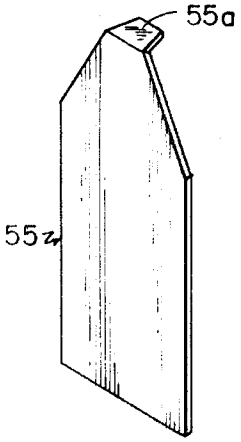


Fig. 17

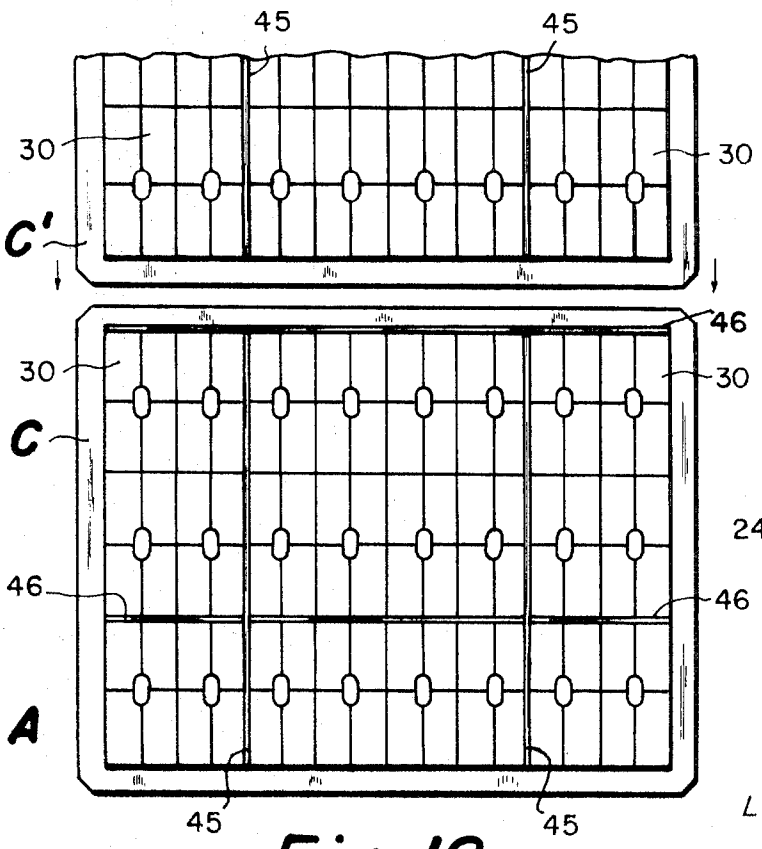


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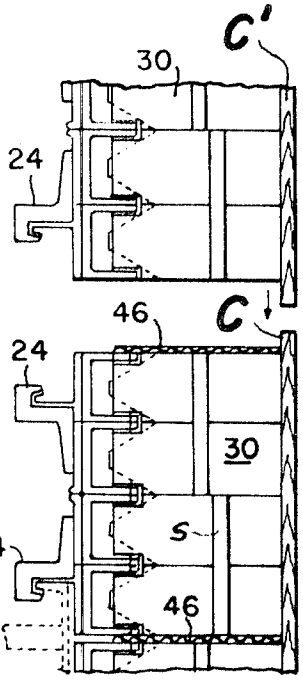


Fig. 18A

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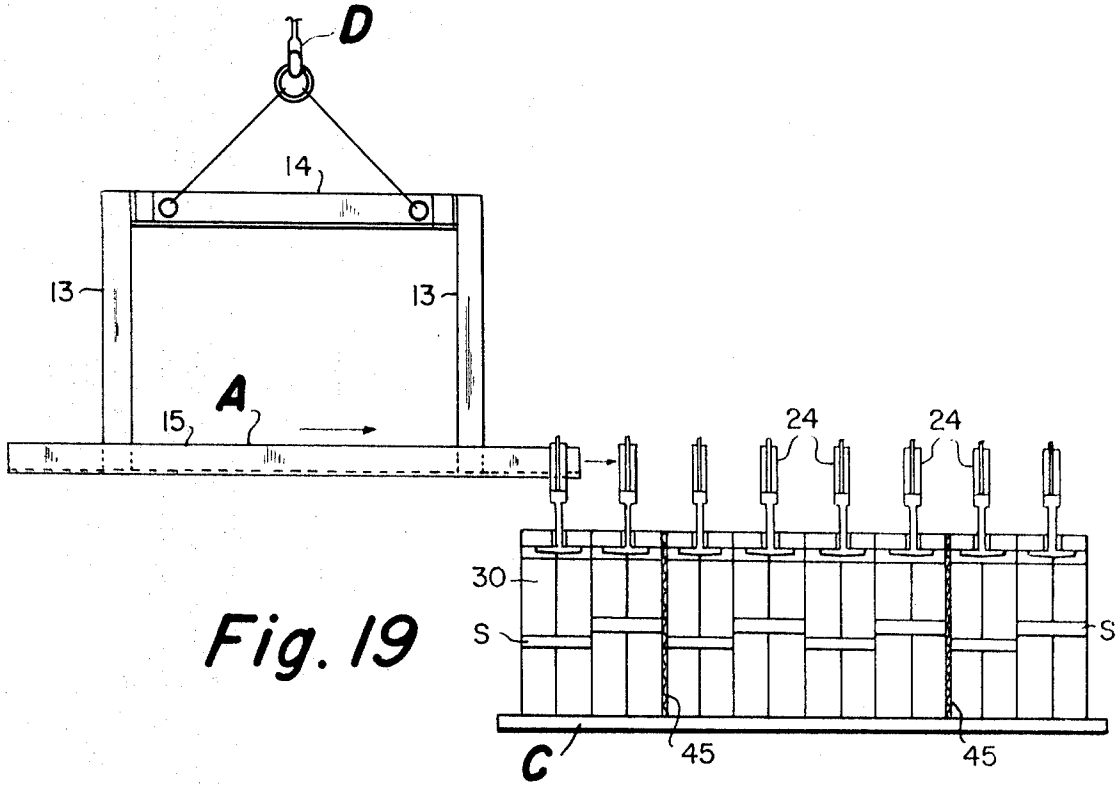


Fig. 19

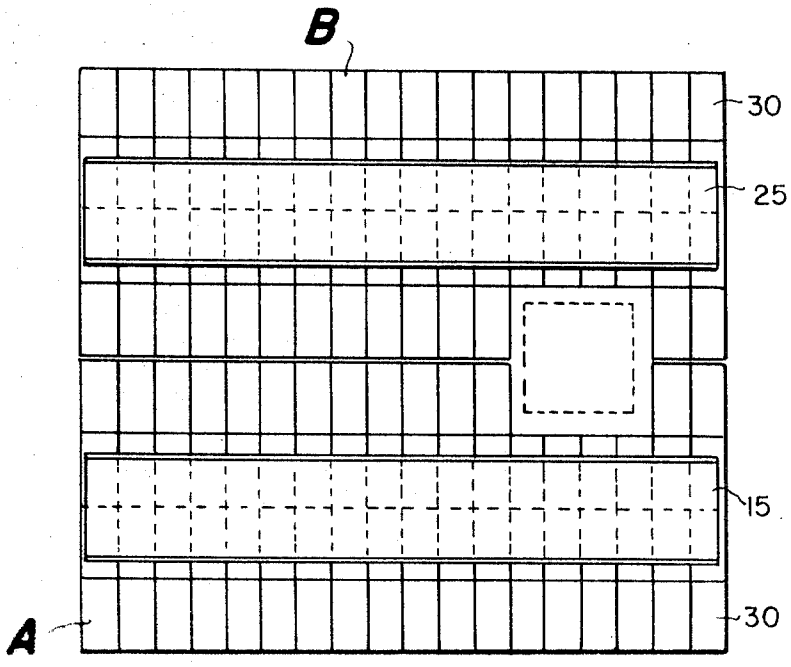


Fig. 20

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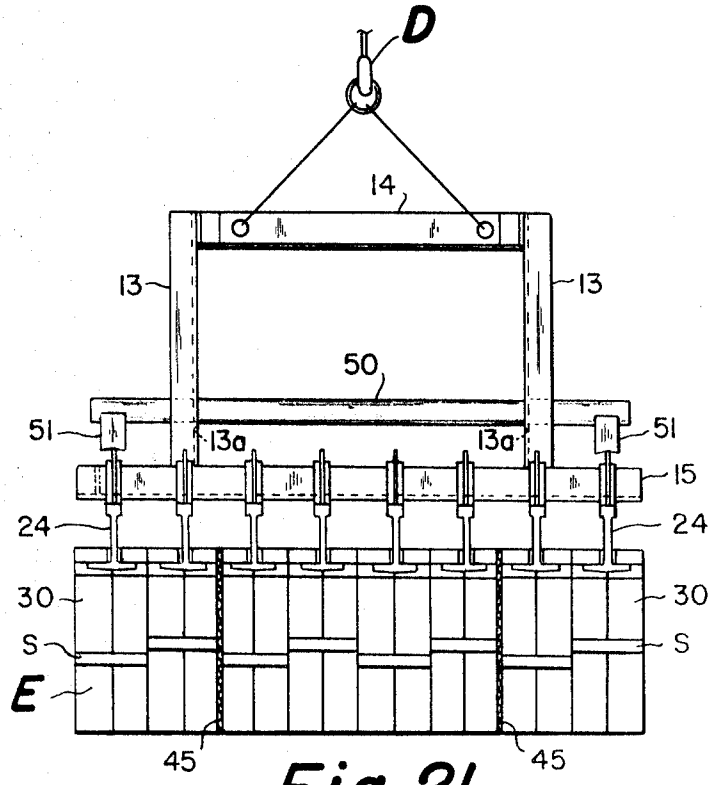


Fig. 21

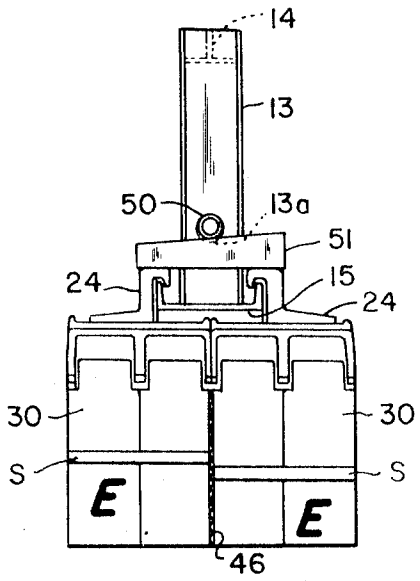


Fig. 22

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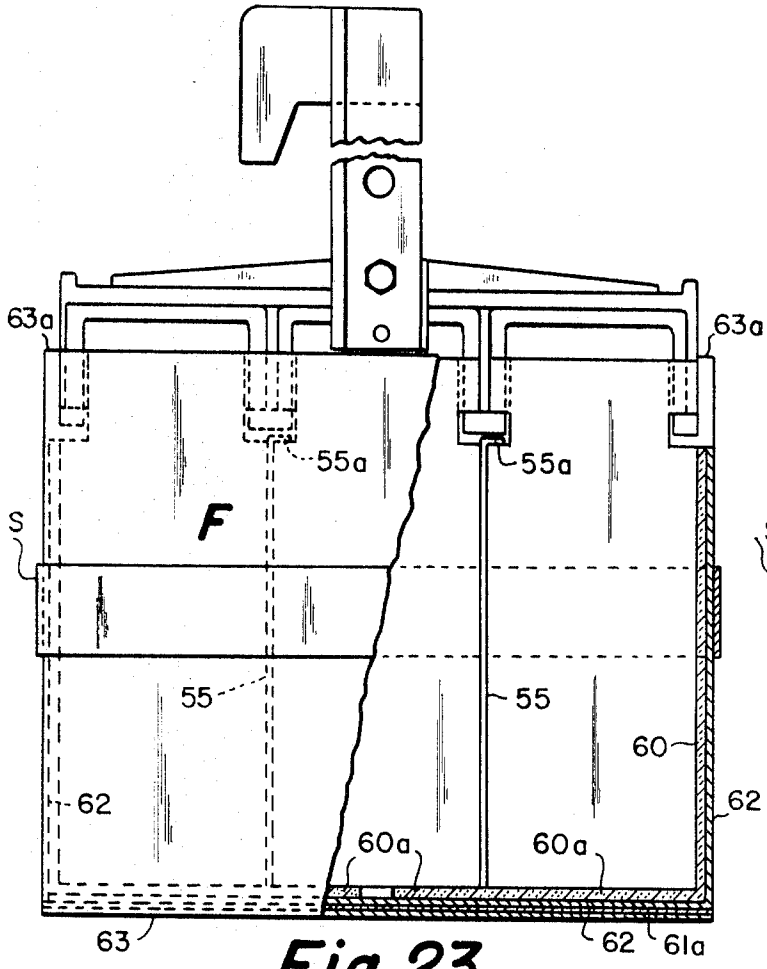


Fig.23

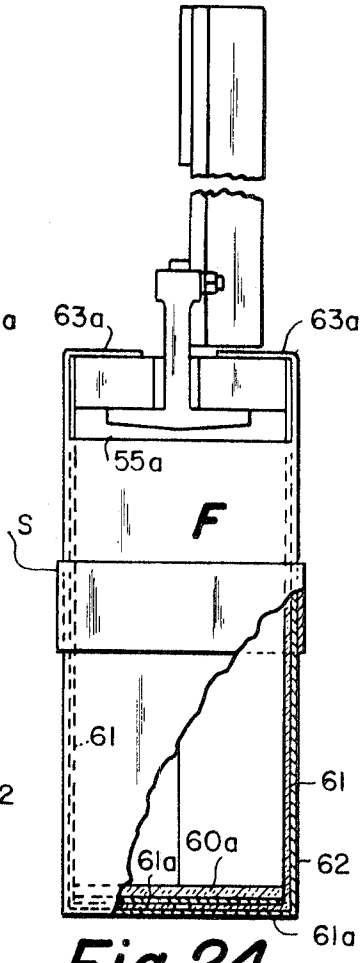


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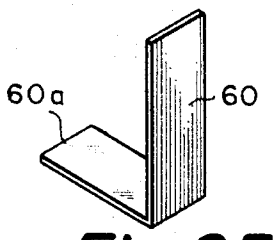


Fig.25

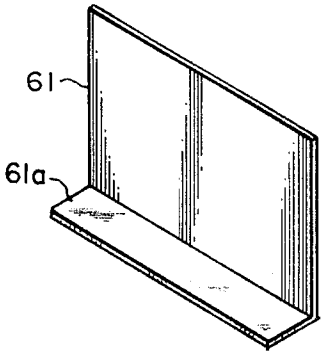


Fig.26

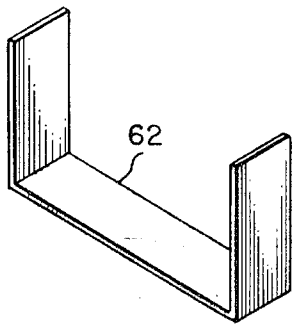


Fig.27

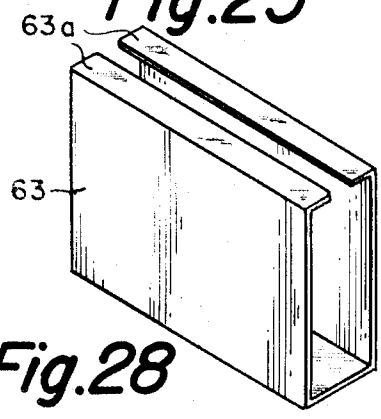


Fig.28

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PANELIZED SUSPENDED ROOF FOR REVERBERATORY FURNACE

The invention deals with constructing a new and improved roof suitable for reverberatory furnaces such as used in the refining of copper metal and particularly, with the provision of a roof construction that will facilitate initial construction, cold and hot patching, air cooling, and segregation and collection of dust and spilled charging materials. A construction of the invention is particularly suitable where an overhead crane or hoist is available.

A phase of the invention deals with new and improved procedure for bundling or assembling refractory tile members, from the standpoint of metal cladding usage, from the standpoint of palletizing them for shipment and assembly, from the standpoint of employing them in a panel assembly, and from the standpoint of employing them in roof patching operations.

Over a period of years it has been customary to utilize so-called silica refractory tile or brick as a suspended roof for reverberatory copper furnace utilization and to apply silica slurry daily to maintain the roof and provide it with a reasonable operating life. Charging materials which may be in the form of a slurry or dried particles are conventionally fed by a continuous conveyor through feed piping, chutes or ducts into the furnace; spilled materials and dust quickly accumulate on the top of the roof which must be promptly removed by daily cleaning, as by the application of compressed air through lances. Accumulated material tends to insulate the top of the tile and to thus concentrate the heat; this increases the tendency to burnout brick or tile members as well as the hanger castings from which they are suspended. It is important to promptly blow off this material, since if it builds up to a thickness of one-half to three-fourths inches it tends to pack and harden, making removal difficult if not impossible without damage to the upper ends of the brick or tile members.

Recently there has been a trend towards the use of so-called basic tile suspended roof constructions and to the use of a roof which at least has a part of its construction panelized in order to provide it with a better period of life and enable the use of higher operating temperatures. Attendant with the use of such an improved type of tile has been the need for facilitating the repair of damaged areas of the roof, without shutting-down the operation of the furnace, without damaging adjacent portions of the roof, and with a minimized discomfort and risk to maintenance personnel. In this connection, panelized assemblies have been found to be advantageous but heretofore have been limited to main or central portions of the furnace roof, with the remaining portions such as the sloped sides, those portions about the charging ducts, etc., requiring individual handling, installation and repair.

There has thus been a need for an improved basic roof construction that will facilitate a substantially full panelization of the structure, and will enable tile and associated hangers to be assembled on a pallet at the refractory plant with corrugated expansion plates in such a manner and arrangement that flexibility of assembly and patching is assured at the plant site.

The need has also been for a construction which in its panelization will facilitate cooling the tile roof and the cleaning-off of spillage and dust that are normally incident to the operation of a reverberatory furnace.

It has thus been an object of the invention to devise a new and improved procedural approach to the installation and repairing of a basic roof for a reverberatory furnace;

Another object has been to devise a new and improved roof construction and assembly whereby substantially full panelizing of the roof from the standpoint of tile bundles and associated overhead structural support assemblies can be utilized throughout, with an attendant improvement in efficiency and life of the structure;

Another object of the invention has been to devise a panelized roof construction which utilizes two types of panel units that are interfitting and which facilitates the insertion and removal of panels, not only in initially assembling the roof, but also in a localized manner in repairing the roof;

A further object of the invention has been to provide a new approach to the bundling and cladding of refractory tile members as suspended from associated hangers for both cold and hot patching operations;

A still further object of the invention has been to provide means in a roof construction for holding down an adjacent or perimeter tile area while removing burned out panel as a unit by pulling it out of position with the crane;

These and other objects of the invention will appear to those skilled in the art from the illustrated embodiments and the claims.

In the drawings,

FIG. 1 is a transverse side section in elevation of a furnace roof constructed in accordance with the invention.

FIG. 2 is a plan fragmental view taken transversely of the roof on the scale of and of the structure of FIG. 1 showing supporting metal or overhead steel structure.

FIG. 3 is a horizontal section taken longitudinally of the roof, partially broken away, and on the line III–III of FIG. 1; this view particularly illustrated panel structure and cooling air flow provided above refractory tile.

FIG. 4 is a longitudinal section in elevation on the scale of FIG. 3 and showing basic construction of the roof.

FIG. 5 is a longitudinal section in elevation on the scale of and of the structure of FIG. 4, showing the metal support structure in somewhat of an exploded relation to particularly illustrate procedure of assembly and disassembly.

FIG. 6 is an enlarged fragmental longitudinal section in elevation taken through a central portion of the roof, particularly illustrating cover plate and baffle means, etc. for controlling cooling air flow, and also illustrating an assembly of a type adapted for hand installation (where no hoist is available).

FIG. 7 is an enlarged front or wide side elevation showing two two-tile bundles, each having a hanger casting part, with one part being supported or carried by the other or primary part through the employment of a latching relation therebetween; in this view refractory tile members are shown provided with metal separator plates and outer metal cladding.

FIG. 8 is an end elevation on the scale of and of the tile group or assembly of FIG. 7.

FIG. 9 is an end elevation on the scale of and of the bundle of FIG. 8 with separator plates but without outer metal cladding.

FIG. 10 is a front or wide side elevation on the scale of and similar to FIG. 7, but illustrating a four-tile bundle; like FIG. 7 this view shows a metal sheathed or clad tile bundle.

FIG. 11 is an end elevation on the scale of and of the construction of FIG. 10.

FIG. 12 is a front or wide side view in elevation of a six-tile member bundle on the scale of FIGS. 7 and 10 and showing a modified two-part form of hanger casting assembly.

FIG. 13 is an end elevation on the scale of and of the construction of FIG. 12.

FIG. 14 is a horizontal section on the scale of and taken along the line XIV–XIV of FIG. 12.

FIG. 15 is an isometric view in elevation of a refractory tile or block member that may be used in the structure of the invention.

FIG. 16 is an isometric elevation on the scale of FIG. 15 illustrating an angle-shaped outer metal plate or cladding member, and

FIG. 17 is a similar view of an inner, separator plate or cladding member, such as may be used in forming tile bundles illustrated in FIGS. 7 to 15.

FIG. 18 is a fragmental plan view illustrating palletizing of tile bundles that may be accomplished by the tile manufacturer before shipment to the construction site; for clarity, the hanger castings which are also installed in the assembly of tile bundles at the factory are omitted.

FIG. 18A is a side view in elevation on the scale of FIG. 18 showing pallet assemblies with hanger castings inserted;

FIG. 19 is an elevation showing a hoist being employed at the work site for inserting a primary structural panel endwise into an interlatching relation with respect to hanger casting pairs; both primary and secondary structural panels are inserted in the same manner.

FIG. 20 is a plan view on the scale of FIGS. 18 and 19, taken transversely of the roof and illustrating support of refractory panels or assemblies by metal channels.

FIG. 21 is a transverse side view in elevation on the scale of FIG. 19 and illustrating how a panel section may be replaced in the furnace.

FIG. 22 is an end view, longitudinally of the roof, on the scale of and of the structure shown in FIG. 21 which shows hold down wedges and pipe.

FIG. 23 is a wide side view in elevation illustrating a hot patching tile bundle assembly constructed in accordance with the invention.

FIG. 24 is an end view in elevation on the scale of and of the construction of FIG. 23.

FIGS. 25 through 28 are isometric views in elevation illustrating asbestos and metal parts used in assembling the bundles of FIGS. 23 and 24.

FIGS. 25 and 26 represent asbestos angle-shaped cladding members and FIGS. 27 and 28 represent metal cladding members of U and boxlike shapes.

In carrying out the invention, refractory tile or brick members 30 may first be preliminarily assembled in bundles and banded with hanger castings, and then reassembled on pallets in the form of palletized assemblies or groups (see pallets C and C' of FIG. 18) for storage, shipment, handling and roof mounting. Roof assembly or installation is accomplished by utilizing two forms or panel types of structural metal overhead support or frame structures. One structural panel, termed a secondary panel B, is to be first removed before repair is made to the other or primary panel A or to its suspended tile assembly. In building the roof, longitudinally spaced-apart primary panels A of two-part construction are first mounted in place and each secondary panel B is then mounted piggy-back to rest at its ends on a pair of the primary panels A. Each overhead structural member panel or panel assembly is adapted to be slid, lowered and lifted into and out of position with respect to transverse or cross-extending overhead, main beam or girder members 10. The mounting is such that steel longitudinally extending cover or sealing plate members 70 (see FIGS. 1, 4 and 6) may be readily utilized to not only close off upper reaches of tile members 30 and their hanger castings from dust and spillage collection, but also to enable cooling air to be circulated in an efficient manner below the plate members 70, along hanger castings, generally designated as 24, and upper ends or reaches of the refractory tile or brick members 30.

A furnace roof using magnesite-chrome or basic type tile is shown made up of interfitting panel sections employing supporting framework and hanger-mounted, banded bundles of tile members suspended therefrom, all in such a manner that a panelized construction may be used substantially throughout the full extent of the roof, cold assembly and repair and hot patching are facilitated, the provision of cooling ducts above the tile members is facilitated, upper reaches of the tile members may be sealed-off from spillage of charging materials and dust that may be recovered for use in the furnace.

Referring to the drawings, the roof is supported by cross-extending girders or I-beam members 10 (see FIGS. 1 to 4) that have a longitudinally spaced-apart relation with each other. The metal roof frame or steel support structure employs so-called end, primary or supporting panel sections A which cooperate with and have cantilever channel members 12 resting endwise on lower flanges of the cross girders or beams 10. Plate members or pieces 11 are weld-secured along the web and between the flanges of the girders 10 in the form of pairs provided as spaced-apart members to reinforce the cross girders 10 and define receiving and alignment compartments or pockets for end portions of longitudinally extending cantilever members 12 which may be bolted thereto. Intermediate or secondary panel sections B have longitudinally extending upper structural channel members 22 (see FIG. 4) that rest piggy-back at their ends on adjacent vertical or upright channel member legs 13 of the primary or main panels A.

Each part of each two-part panel A has, as shown particularly in FIGS. 1 and 4, a pair of spaced-apart upright or vertical channel members 13 which are integrally connected adjacent their upper ends by cross-extending horizontal tie members 14 of an I-web and bottom flange construction to rest on a pair of spaced-apart, longitudinally horizontally extending, cantilever channel members 12. Cantilever members 12 are adapted, as shown in FIG. 4, to removably rest upon a lower flange 10*a* of an associated cross girder or beam 10. The vertical or leg members 13 of each part of panel A are provided with an upwardly open, horizontally, cross-extending, support and connecting lower channel 15 which is integrally secured thereto as a foot for the metalwork thereof. Opposite flanges of each connecting channel 15 are adapted to serve as receiving edges for gooseneck portions of tile suspending hangers or hanger castings, generally designated as 24.

Each central or secondary panel B has a pair of longitudinally spaced-apart, upright or vertical channel member legs 20 that are secured adjacent their upper end portions in a reinforced manner by angle members or pieces 21 to a pair of transversely spaced-apart, horizontal, longitudinally extending, channel members 22. Opposite ends of the channel members 22 of each panel B, as shown particularly in FIG. 4, are adapted to rest in a cantilevered manner on upper ends of vertical leg members 13 and the connector members 14 of a pair of longitudinally spaced-apart adjacent panels A for support thereon and thus, for indirect support on girders 10 through the agency of a pair of opposite end-positioned panels A. Each secondary panel B has a pair of transversely spaced-apart frame members that at the lower ends of their legs 20 are integrally secured to a transversely or cross-extending upwardly facing, hanger casting supporting, channel member 25 (see FIGS. 1 and 4). The channel members 25, like the members 15 of panels A, serve as a mounting or supporting means for gooseneck hooks of the hanger castings, generally designated as 24.

The above construction, with notched girder ends, allows the roof to be installed at the highest possible elevation to obtain maximum bank area and, at the same time, to provide sufficient space for repair and other maintenance work. As shown particularly from FIGS. 1, 3 and 4, the roof of the present construction is completely panelized, including the area under the cross girders 10 and around feeder pipes or ducts. As a result, the entire roof can now be installed, replaced and repaired with an overhead crane and its hoist, except possibly for a couple of bundles of hand-mounted tiles used behind feeder pipes or ducts. The central panel B may be approximately 4 by 4 feet and the end panels A may be about 4 by 2 feet.

Basic refractory tile or block members 30 are hung from the upturned flange or leg portions of the connecting, bottom support channels 15 and 25. The tile 30 are assembled as shown in FIGS. 7 to 14 in bundles that may be held together by steel bands S after assembly. Such bundles may be in the form of six tiles, four tiles or two tiles, with the two tile arrangement E of FIGS. 7 and 8 being preferred where the tiles 30 are to be placed in the form of a panel assembly or section by hand rather than by the use of the overhead crane hoist. A casting on casting assembly 35, 36 such as illustrated in FIGS. 6, 7 and 8 is adaptable for hand patching and personal access. A portable patching rig or platform with windlass may also be used for roof construction and repair work. In the two bundle assembly shown in FIGS. 7 and 8, the tile members 30 are assembled with secondary hanger part 36 of one casting assembly engaging and being cantilevered or suspended from a primary hanger part 35. In other words, the tile members 30 in a banded, two tile bundle E or assembly are, in effect, cooperatively mounted with respect to each other in such a manner

that one transverse row of tile members 30 may be hooked in position over a second transverse row through the agency of their respective cooperating hanger castings 35 and 36.

FIGS. 10 and 11 show a four tile bundle having a single type of hanger casting 37. In the six tile bundle of FIGS. 12 to 14, a larger casting 38 is shown which may be provided with a separate, removably mounted gooseneck hook 39. This type of casting may be used where it is impractical to form a hook on a larger size casting, or if the length of the gooseneck is to be extended or is to be varied for different furnace installations. As shown in FIGS. 12 and 13, the hanger casting 38 has a projecting lug 38*a* which fits within a complementary hole in the gooseneck part 39, and has an opening adjacent its lower end through which a nut and bolt assembly 40 may extend to provide a secure, removable mounting on the hanger casting 38.

FIG. 18 of the drawings illustrates how refractory tile or block members may be assembled in an upright-positioned relation on a pallet C or C' in a group assembly that is compatible with a final desired hanger assembly for storage and shipment to the place of installation of the roof. At the factory, the tile members will be assembled in bundles on a level surface with the slot portions of tile pairs being matched, hanger castings will be inserted, metal reinforcing plates will be added, the bundles will be banded, and then the banded bundles will be assembled on a pallet with longitudinally and transversely extending expansion plates 45 and 46 inserted. As indicated in FIG. 18A, opposed pairs of inturned hangers 24 provide a cross-extending tile row group to, at the place of roof installation receive a common support channel see, for example, FIG. 19. At the place of roof installation, a pair of pallets C and C' may, as indicated by the arrows of FIG. 18, be moved into endwise abutment and a longitudinal expansion plate 46 inserted between a tile row of one pallet C and an adjacent tile row of the other pallet C' to provide a desired width of assembly for installation. For example, an additional transverse expansion plate 46 inserted between may be inserted between adjacent tile rows of a pair of pallets C and C' at the place of roof installation to provide about a 4 foot by 4 foot assembly, assuming that each pallet supports a 4 by 3 foot assembly.

I prefer to employ corrugated metal expansion plates 45 and 46 at about 2 foot intervals in each direction; the corrugations should extend horizontally to enable sealing off the cooling air flow. FIG. 19 illustrates how pallets C may be used at the place of installation for panel structure insertion. The hanger castings generally designated as 24 have been inserted at the brick plant with their feet in the upper end slots of the tile members 30 before banding into bundles of a desired longitudinal extent and of two tile widths or transverse extent. Each bundle is banded by a steel tie S which may consist of strap metal welded at its ends. Thence, a panel frame B or a panel frame part of representative frame A, may be inserted or moved endwise until its bottom channel 25 or 15 receives the generally designated hangers 24 of the assembled group of hangers. The hangers interlatch along opposed upright side flanges of the channel member 25 or 15, see the arrow of FIG. 19, see also FIG. 20 and the ultimate panel assembly represented in FIGS. 4 and 6.

Referring particularly to FIG. 5, I have somewhat diagrammatically illustrated how the panel sections A, B, may in a step-by-step manner be assembled with respect to each other to form a completed furnace roof. A pair of opposed, short-length, horizontal cantilever members 12 are moved endwise into an opposed aligned relation on the bottom flange 10*a* of an associated girder 10 and are secured as by bolting them to reinforcing pieces 11 thereof. An upright rectangular frame part, made up or a pair of upright leg members 13 and an upper, longitudinally extending, horizontal connecting member 14 and a suspended, integrally secured channel member 15, see FIG. 19, is provided with an assembly of tile members 30 as suspended by hangers 24. This frame part and tile assembly is then moved endwise into a final position such as further illustrated in FIGS. 1, 3 and 4, at which time the cross member 14 of each frame part of panel A rests upon and is suspended from the upper flange of an associated cantilever member 12.

Appropriate metal framework channels 15 or 25 for the panels A or B may be slid endwise into position along the hangers (see the arrow of FIG. 19) in such a manner that the hanger will then be suspended from associated channel support member 15 or 25. At this time, a hoist D of an overhead crane may be secured as indicated in FIG. 19 to a central, horizontal, longitudinally extending member, for example 14, to lift each part of panel A into an overhead position in alignment with the space to be filled. The hoist D may also be used to lower panel B to a piggy-back mounted position on the pair of previously mounted side or end panels A.

After the outer part assemblies of A have been moved into the final suspended position of FIG. 5, then the inner panel assemblies of A are moved in the same manner (see the arrow) into a suspended position illustrated in FIG. 4. At this time, a pair of tile assemblies of panel B whose hangers have been introduced endwise along foot channels 25, is then lowered (see the arrow) into a cantilevered, supported position on the panel assemblies A, as illustrated in FIGS. 4 and 5. To ready the roof for repair, the above-explained procedure may be reversed.

In FIGS. 21 and 22, I have shown a removable wedge and pipe or rod type of holddown which can be used to securely lock tile bundles E on a panel for safe handling; the holddown assembly may also be employed to brace perimeter edges around a patching hole when an existing panel is to be pulled-out for repair. Vertical upright or leg members 13 of the panels A are shown provided with a cross opening or hole 13*a* therein, and the upright or leg members 20 of the panels B (see FIG. 4), with a cross opening 20*a* therein to removably receive a pipe or rod 50 which will extend between pairs of upright members 13 or 20 that carry integral bottom channels 15 or 25 transversely of the furnace; these channels carry the hangers 24 in a suspended relation therefrom. When speaking of a channel, I have reference to a channel-shaped member construction. Wedge blocks 51 may be driven in between the hook portions of the hangers 24 and the cross-extending pipe or rod 50 to prevent accidental release of the hangers from the channel 15 when, for example, the roof is being patched, and particularly when a panel or section A or B is being handled by the hoist D of an overhead crane. After installation has been completed, the wedges 51 may be knocked-out and the cross-extending pipe or rod members 50 may be removed.

The holddown construction illustrated in FIGS. 21 and 22 may also be used in accomplishing an original installation, in that it serves to lock the tile and hangers in place on a metal panel structure, in order that none of the tile or castings can be knocked off during handling. It is particularly advantageous during cold or hot patching in that it can be used with panels surrounding the hole or portion to be patched to hold their tile members in place.

Present practice of using, in alternate fashion, plated and unplated tile, causes a considerable variation in size when assembled into panels. It is thus practically impossible to get a plated and unplated tile to the same uniform size that will make them a good matching pair. It is proposed to group unplated tiles in bundles of two, four or six members, with these bundles being equipped with loose internal separator type plates 55 (see FIGS. 7, 8, 14 and 17), and in an initial or cold patch installation to apply angle-shaped outside plate members 57 (see also FIG. 16). The plate members 57 will have one wing, upright side face or panel portion 57*a* of a width or horizontal extent corresponding to the width dimension of the wide side face of an associated tile member (see FIG. 14). Its other panel or plate wing portion 57*c* will have a width or horizontal extent corresponding to the total width of the end assembly of the tile which is to be banded; as shown, the width will constitute the endwise-width extent of two associated tile 30 of a bundle. Thus, one separator plate 55 and one outer

angle-shaped plate 57 serves to provide coverage for each pair of tile members 30; one plate 57 is used for each joint. The one exposed wide side face and the one exposed end side face of the bundle of FIG. 14 is, in effect, covered by the plates 57 of an associated bundle to provide a metal-enclosed assembly.

In accomplishing roof construction and patching employing the structure of the present invention, refractory tile tile block members 30 are grouped in a suitable manner and banded. As shown in FIGS. 1 and 14, tile members 30 are formed in a bundle E with a pair of members providing the narrow-dimension, as separated on the adjacent wide side faces by a metal separator plate member 55; two or more tile members 30 may be used in each bundle as held together by the continuous steel band or ribbon S (see FIG. 12). Top tabs 55*a* on separator plates 55 and top tabs 57*b* on the outer angle plates 57 are adapted to rest on upper end faces of tile members 30 of the bundle to aid in properly positioning and retaining them in a positioned relation. Bundles of two, four or six tile bundles may be provided in the above manner with metal sheathing.

Where hot patching is to be accomplished, I contemplate removing at least a section of tile members or a panel and corrugated expansion members 45 and 46 so as to provide sufficient spacing for the insertion of the hot patch tile assembly. It is important in this connection to provide a hole size somewhat larger than the patching unit. This is especially important when the panels are to be maneuvered into place with an overhead crane. Referring to FIG. 4, a group assembly B of tile member groups or rows 47 that are supported on or suspended from a pair of channel members (such as 25) may be removed, as indicated in FIG. 5, followed by pulling out two groups 47 (see FIG. 4), as indicated at A of FIG. 5, to provide a patching hole. Of course, exposed immediate expansion plates 45 and 46 are removed. In the drawings 47 designates an aligned row or group of cooperating tile members that are suspended from a common support channel 15 or 25.

To provide a heat shield where hot patching is being employed, an asbestos enclosure is used (see FIGS. 23 to 28) that is made up of a pair of end pieces 60 having bottom extending tabs or flaps 60*a*, and of wide side pieces 61 having bottom tabs or flaps 61*a*. This provides an asbestos cover for all four sides of each hot patch bundle F that has a double thickness at its bottom face (see FIG. 23). A U-shaped upwardly projecting metal cladding piece 62, such as of stainless steel, encloses the bottom face and the side narrow faces of the tile assembly or bundle, and a second U-shaped or boxlike rectangular metal member or part 63 covers the wide faces and the bottom face and has top tabs 63*a* that hook over the top face of the tile members of the assembly F. Hot patch assembly or bundle F is also bound with a steel strap S and will be installed without corrugated expansion plates, since the asbestos pieces will decompose and provide thermal expansion space for the new tile assembly.

The upper flaps of both the banded cold assemblies E and the hot assemblies F serve to provide an additional reinforcement of the tile in their mounted relationship, since such flaps or flanges extend above and along the slotted portions which receive the feet of the hanger castings from which they are suspended. The steel band or strap member S is used after each bundle has been completed for holding it in a banded relationship. Since the bundles are to be assembled in an adjacent relation, the steel band S on each bundle is staggered with respect to the bands of adjacent bundles as shown in FIG. 19.

Referring TO FIG. 4, the cross-extending I-beams or girders 10 may have an 8 foot spacing with respect to each other longitudinally of the suspended roof. The tile 30 are shown suspended in a two row, 12 inch wide band arrangement with four tile to the band. This presents a weight of about 132 lbs. per bundle. Each hanger casting or assembly 24 supports a bundle E and is hung in a facing and matching relation from opposite sides of the channels 15 or 25, with the refractory parting line between the central bundles of panels A extending under and along a centerline of the associated cross girder 10.

The dual hanger assembly in FIGS. 7 to 9, inclusive, is particularly suited for an installation where no overhead crane is available and the tile and hangers are to be installed by hand. See particularly FIG. 6. In a roof construction for this purpose, a casting carrying two rows of tile, as indicated in FIG. 4, will be paired-off with a two row casting assembly, such as shown in FIG. 7, wherein each casting part is of a single tile row supporting construction. For manual installation and repair, a construction such as illustrated in FIG. 6 has been employed to give sufficient operating room, to facilitate shifting steel supports for access, and to enable such tile units as 1 and 2 to be separately removed and inserted. In FIG. 6, prime affixes have been employed to designated members that correspond to those of the embodiment represented by FIG. 4, but that have been slightly modified for manual as distinguished from hoist or crane installation procedure.

By closing-off the upper reaches of the tile members 30 of the roof with steel cover plates 70, high velocity cooling air may be utilized for increasing the operating life of the steel framework as well as of the refractory tile. In this connection, metal or steel cover plate members 70 (see FIGS. 1 and 4) are removably positioned to rest in horizontal positions above the upper sides of hanger castings generally designated as 24. The members 70 have, as shown, turned-down end or side portions that project downwardly to set or rest on the channels 15 and 25 between their flanges and upright members 13 and 20 to provide an effective sealing-off relation for the cooling air flow. The members are also shown provided with central, downwardly extending or vertical baffle portions 71 (see also FIGS. 4 and 6) that extend down to the upper face of the tile in alignment with the separation line between a longitudinal row of tile members 30, see FIGS. 3 and 4. In addition to materially increasing the life of the group, this will eliminate the daily task of blowing the roof clean. In FIG. 3, I have shown a pair of cooling air inlet and outlet header pairs or mains 75*a* and 76*a* that are connected by transverse secondary lines 75 and 76 to roof inlet and outlet ports. I have shown each 8 foot length of roof between girders 10 as equipped with four air inlets 75, two on each side, and four straight-line air outlets 76, one for each opposite side inlet 75; it will be noted that the inlet and outlets 75 and 76 are alternatively positioned along each side of the roof to provide adjacent cooling fluid or air flow passage that is in opposite directions across the roof. Each inlet port 75 (see FIGS. 1 and 3) may be supplied with, for example, 2000 c.m.f. of air at a pressure of 6½ inches W.G. which provides a total of about 8,000 c.m.f. for each 8 foot length of roof. Baffles 71 are positioned so as to force the incoming air from one side port 75 to flow across the roof through a well defined duct and to exhaust through exhaust port 76 on the opposite side between two adjacent inlet ports 75. Thus, each 8 foot by 30 foot section or 240 square feet of roof may be completely covered and cooled by four blanket type air streams.

Members 71 are positioned so that they can extend downwardly in the space between tile bundles at the expansion joint thereof. They also extend to said walls 72 to provide separate crossflow passageways or compartments for the cooling air flow. All, or only the central hottest area of the roof construction may be cooled and a multifan set for supplying the air to the mains or headers 75*a* has been found to be preferable to a single fan supply.

The plate members 70 will preferably, as shown, extend over the major area of the furnace roof, not only as cover plates for the flow of cooling air, but also to facilitate the collection and removal of dirt, dust and debris which normally accumulates along the upper side of a reverberatory furnace roof. Referring particularly to FIGS. 1 and 2, a conventional feed conveyor 80 is shown for supplying lime or other suitable furnace feed materials through a chute or hopper 81 and fettling openings 83 into the furnace. A cover apron 85 of platelike steel metal construction is shown positioned to form an extension of the cover plate members 70 across an air outlet opening to feed dust, etc., collected into the upper end of a

vertically downwardly extending dust hopper **86**. The hopper **86** may, as shown, deliver the dust and debris, as scraped from the top of the members **70** and **85**, into a collecting car or bin **87**. Thus, the debris may be used as charge material by periodically dumping it on the feed conveyor **80**.

The suspension used in the construction fully meets the unique operating requirements of a copper reverberatory furnace. It will be noted that the intermediate roof supporting steel structure is located below the top flange of the cross girders **10** in such a manner as to clear all walkways and platforms. It is of a stiff-leg design that places a series of rigid support channels within a reasonable working distance of the roof tile, and the spacing of the steel legs allows ample walkway clearance, both transversely and lengthwise of the furnace. The supporting steel in the form of panels or assembly sections enables the suspended roof to be installed or patched with a small 10 ton overhead crane. Where a crane is not available but a portable rig is, installation and patching can be accomplished in bundles such as represented by E of FIG. **12**. Such bundles can be handled with a portable patching rig having a hand-cranked windlass mounted on top of the roof steel or bundles E of FIG. **7** may be handled by hand if no rig is available. The bundles may be delivered to the patching area by a roller conveyor located under the patching rig. An area representing one-half of the roof between girders **10** and four bundles transversely across the furnace can be prepared without moving the rig which may then be slid skid-fashion to cover the remaining half of the area. With reference to FIG. **6**, if a hand or manual type of roof repair is to be accomplished, it is necessary to shift the left-hand steel over to get a tile group under a girder **10**.

A pullout type of dismantling roof area that is to be replaced is now practical utilizing the structure disclosed; hanger castings can be salvaged and the amount of debris that is dumped into the furnace minimized.

FIGS. **14** through **17**, inclusive, illustrate with FIGS. **18** and **19**, a procedure for effecting an original roof installation, as well as for cold patching which involves the use of a metal or steel separator plate **55** and an angle plate **57** for each pair of tile, which pairs are assembled into tile bundles. Hangers are inserted in the bundles and the bundles are banded by a steel metal strap or rib member S. Each bundle is then assembled with adjacent bundles on a pallet with metal or steel longitudinal and transverse corrugated expansion plates or members **45** or **46** being employed about every 2 feet both ways, see for example FIG. **18**. The pallet assembly is then handled as a unit in storage and shipping to the place of roof installation and may be used with an adjacent pallet to provide a final desired size of roof assembly for installation. In this connection, if each pallet has a length of 4 feet and a transverse extent of 3 feet, then an additional tile row taken from an adjacent pallet C' may be assembled with the assembly of particular pallet C, with a suitable corrugated expansion member **46** being inserted therebetween.

The assembly as thus made available by a pair of pallets, may then be lifted by an overhead crane or hoist and moved to a suitable overhead delivery position at which the assembly may then be mounted in a manner such as illustrated in FIG. **19** by supporting steel channels through aligning hangers. When this has been completed to provide each line or row of hangers with an assembled suspended positioning on an associated overhead channel, then the entire assembly may be lowered into position in the roof where it is to be mounted.

Where hot patching is to be accomplished, the expansion plates **45** and **46** are no longer necessary and tile member bundles F are formed as illustrated in FIGS. **23** to **28**, inclusive, by the use of asbestos and steel sheathing or enclosing part assemblies. The bundles may then be assembled in bundle groups, such as previously illustrated and described, and preferably in locked hanger groups as shown in FIGS. **21** and **22**, but with the expansion plate members **45** and **46** omitted. The asbestos portions of each bundle F serve to provide for expansion after the installation has been completed, in that the asbestos material is soft and also tends to disintegrate under the heat to which the roof is subjected. The procedure of the present invention greatly simplifies the initial installation of and the repair or replacement of a furnace roof. Further storage at and shipment from the refractory plant is simplified, maximum assembly is accomplished at the factory, panel steel mounting is simplified at the place of installation, and handling and mounting is simplified at the place of installation. Finally, effective and efficient tile assembly sizes for storage, shipment, handling and installation are made practical.

As shown in FIGS. **1** and **4**, a panel assembly or group of tile members **47** may include a pair of longitudinally extending expansion plates such as **45** and a transversely extending expansion plate such as **46**, and is handled with inner expansion plates in position. The tile members are carried in an aligned row by the hanger castings, see the representative castings **35**, **36** of FIG. **7**, **38** of FIG. **12**, and **24** as generally designated in FIGS. **21** and **22**. As shown in FIG. **22**, each row may have a pair of row parts, represented by E, with the hanger castings **24** of one part and inserted reinforcing metal plates or separating side and bottom metal plates or sheathing being secured in position by banding the group assemblies of the tile members together. It will be noted that the hangers of one row part face in one direction and are in an opposed and aligned relationship with the hangers of the other row part of the same pair to latch-engage over the side flanges of a common associated channel-shaped support member **15** (or **25**), see also FIG. **5**.

I claim:

1. In a method of providing a suspended roof construction, assembling at least a pair of slotted refractory tile members in an aligned position with respect to each other, inserting a hanger casting in the slots of the aligned tile members to project therefrom, inserting loose metal reinforcing plates between the aligned tile members, banding the aligned tile members as a group together with the petal plates in position and with the associated hanger casting within the slots to form a secure assembly, and providing asbestos members between the tile members and the metal plates before banding the tile members together as a group.

2. In a method of providing a suspended roof construction, assembling slotted refractory tile members with their slotted portions in a cooperating relation with respect to each other, inserting hanger castings within cooperating slotted portions of the assembled tile members to project endwise therefrom, inserting loose metal reinforcing plates between the assembled tile members, banding assembled tile members together in the form of groups with the metal plates and the hanger castings in position to form secure assemblies, and employing an expansion-permitting means by applying an asbestos sheathing and an outer metal enclosure about each banded group of tile members before banding the group and assembling it on the pallet.

3. In a panelized suspended roof construction for removable mounting between an adjacent pair of spaced-apart overhead girders, metal hangers, aligned rows of hanger-supported refractory tile members, reinforcing metal plates between the tile members of said rows, means banding groups of the tile members of said rows together with said metal plates in a secure position therebetween, metal support members cooperating with said hangers to removably suspend said rows between the girders, said plate members having members along side and bottom portions of the tile members of said banded groups, and asbestos sheathing between said plate members and side and bottom portions of tile members of said banded groups.

4. In a panelized suspended roof construction for removable mounting between an adjacent pair of spaced-apart cross-extending overhead girders, a pair of longitudinally spaced-apart primary panels and an intermediate secondary panel of metal-supported and suspended refractory tile members; each primary panel being of similar construction and being suspended from an associated one of the girders; each primary panel hav-

ing a two-part construction, each part of which has transversely extending rows of hanger-mounted refractory tile members suspended from a transversely extending channel member, each part also having a vertically upwardly and horizontally inwardly projecting metal supporting frame secured to said channel member, said supporting frame of one part of said pair being adapted to extend towards the associated girder and to removably rest upon an adjacent bottom flange and extend from one side of the rib thereof, said supporting frame of the other part of the same pair being adapted to extend towards and rest upon an adjacent bottom flange of the same associated girder from an opposite side of its rib and in an opposed relation with respect to said first-mentioned frame; said secondary panel having transversely extending rows of hanger-mounted refractory tile members suspended from spaced-apart transversely extending channels and having an overhead metal frame that is secured to and projects upwardly from the channels and that projects horizontally outwardly at an upper level to rest upon said pair of primary panels that are located at opposite ends of said secondary panel and suspended from the pair of spaced-apart girders.

5. In a roof as defined in claim 4, said overhead metal frame of said secondary panel having at least a pair of spaced-apart horizontally extending overhead support members that are connected by spaced-apart vertical leg members to the channels of each of the rows of sad secondary panel.

6. In a panelized suspended roof construction for removable mounting on an adjacent pair of longitudinally spaced-apart cross-extending overhead girders, a pair of spaced-apart end panels comprising hanger-suspended refractory tile member rows, each end panel of said pair being in alignment with and supported on an associated one of the girders, an intermediate panel having hanger-suspended refractory tile member rows carried by vertical upright members and horizontally extending members that define a supporting frame, said horizontal members of said supporting frame having end portions that are removably supported on and with respect to the pair of cross-extending girders, said intermediate panel having an upwardly open and horizontally extending channel for each of its tile member rows, and the hanger castings of each tile member row being mounted in an endwise-insertable removably suspended relation on an associated one of said channels.

7. In a roof construction as defined in claim 6, the vertical upright members of said supporting frame of said intermediate panel being spaced-apart upright metal members secured at their lower ends to said horizontal channel members, and said horizontally extending members of said supporting frame being overhead longitudinally extending and spaced-apart metal suspension members to which upper ends of said vertical upright members are secured and which at their ends are suspended from the pair of adjacently spaced-apart girders.

8. In a panelized suspended roof construction, a plurality of refractory tile member rows in an aligned group, hanger castings suspending each tile member row, a transversely extending channel member slidably receiving the hanger castings of each tile member row, an overhead metal support structure suspending said tile member rows in an assembled relation, upper reaches of said hanger castings and of said channel members being in a substantially planar-aligned position along the construction, cover plate members positioned over said channel members and said hanger castings to seal-off upper reaches of the hanger castings and the tile members and to define a cooling air circulating spacing between upper reaches of said hanger castings and upper reaches of said tile member rows, and means for moving cooling air beneath said plate members along the upper reaches of said tile member rows.

9. In a panelized roof construction as defined in claim 8, means cooperating with said cover plate members for directing the moving cooling air from one side of the roof construction to the opposite side thereof.

10. In a roof construction as defined in claim 8, said plate members being positioned in a relatively planar relationship with respect to each other to receive spilled dust and additives thereon for ready removal from the construction above said hanger castings and said tile member rows.

11. In a roof construction as defined in claim 8, spaced-apart upright metal members secured at their lower ends to said channel members, and overhead horizontally extending spaced-apart suspension members secured to the upper ends of said upright metal members.

12. In a roof construction as defined in claim 11, means defining compartments along the upper reaches of said refractory tile member rows transversely of the construction and substantially parallel to said channel members, and means for introducing cooling fluid into alternate compartments taken longitudinally of the construction from opposite sides of the construction and for removing warmed cooling fluid after it has passed across the roof construction from alternate compartments along opposite sides thereof.

13. In a quick servicing panel construction for repairing a furnace roof, a longitudinal row of a banded together group of refractory tile members having slotted upper end portions, hanger castings mounted in said slotted portions and projecting upwardly in an aligned relation along the row, a slide-in channel member inserted along and engaged by the aligned hanger castings, an overhead support frame adapted to be suspended from an overhead hoist, said support frame having at least a pair of spaced-apart vertical legs secured at their lower ends to said channel member, a cross-extending member projecting through said pair of legs in alignment with said channel member, and wedge-shaped members driven between opposite end portions of said cross-extending end member and immediately adjacent hanger castings to securely suspend said rows from said support structure for transportation to and insertion within an open portion of the roof that is to be repaired.

14 In an improved hot patching refractory tile member construction, an endwise-aligned group of upright refractory tile members having wide side faces and narrow end faces, asbestos angle-shaped members enclosing outer wide side and end faces of the group as well as bottom faces thereof, and metal sheath members enclosing said asbestos members.

15. In a construction as defined in claim 14, said asbestos members comprising a pair of angle-shaped side members, each having a vertical portion of a height and length substantially corresponding to the height and length of wide sides of the group and having a horizontal bottom portion of a length and width substantially corresponding to the length and width of an underside of the group, and said asbestos members also comprising a pair of angle-shaped end members having a vertical portion of a height and width substantially corresponding to the height and width of narrow ends of the group and having a horizontal bottom portion of a width substantially corresponding to the width of an underside of the group and of a length substantially corresponding to one half the length of the underside.

16. In a construction as defined in claim 14, said metal sheath members comprising a U-shaped metal member having a bottom horizontal portion of a length and width substantially corresponding to the length and width of an underside of the group and having vertical end portions extending from ends of said horizontal portion, each having a height and width substantially corresponding to the height and width of narrow ends of the group; and a rectangular-shaped metal member having a pair of opposed vertical wide side portions of height and length substantially corresponding to the height and length of opposed wide sides of the group, having a horizontal bottom portion connecting bottom edges of said pair of vertical wide side portions and of a length and width substantially corresponding to the length and width of an underside of the group, and having a pair of horizontal upper tab portions connected to upper ends of said wide side portions and of a length substantially corresponding to the length of an upper side of the group and of a lesser width than the upper side of the group.

17. In an improved cold patching refractory tile assembly, aligned rows of refractory tile members each of which has a pair of wide side faces and a pair of narrow end faces, each tile member having a latching slot portion at an upper end thereof, matching pairs of the tile members having their slot portions in a cooperating complementary group, each complementary group of slot portions having a hanger casting mounted therein and extending across the aligned tile rows to project thereabove, said aligned rows comprising at least one pair of said tile members positioned with their adjacent wide side faces in an opposed relation with respect to each other, vertically extending metal separating plates of planar construction between the opposed wide side faces of each said pair of tile members, angle-shaped vertically upwardly extending metal sheath members each having one side closing off narrow end faces of the pair of tile members and having its other side closing-off and extending along an outer wide side face of said pair, and metal banding strip means about the aligned rows of said tile members to hold said metal plate and sheath members in position and said tile members in an assembled relation.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,589,316 Dated June 29, 1971

Inventor(s) Levi S. Longenecker

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 38, after "46" delete "inserted between"; line 70, change "or" to --of--.

Column 8, line 13, change "designated" to --designate--; line 58, change "said" to --side--.

Column 10, line 37, (claim 1) change "petal" to --metal--.

Signed and sealed this 4th day of January 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents