April 2, 1968 F. P. MERKLE, JR 3,375,795

PANELIZED FURNACE ROOF

Filed June 11, 1965 4 Sheets-Sheet 1

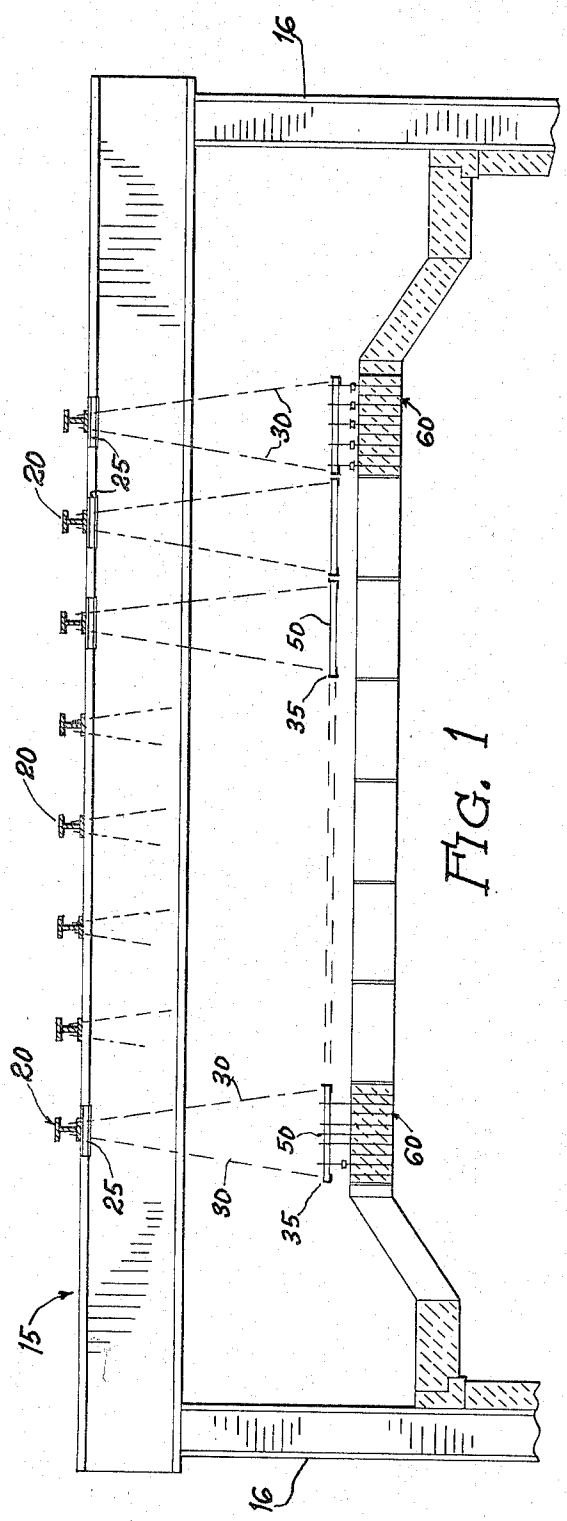

FIG. 1

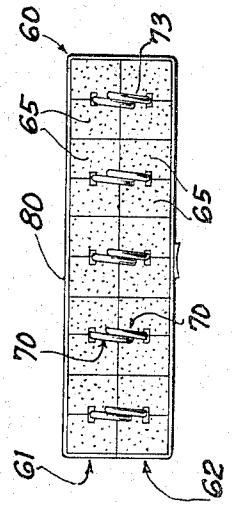

FIG. 10

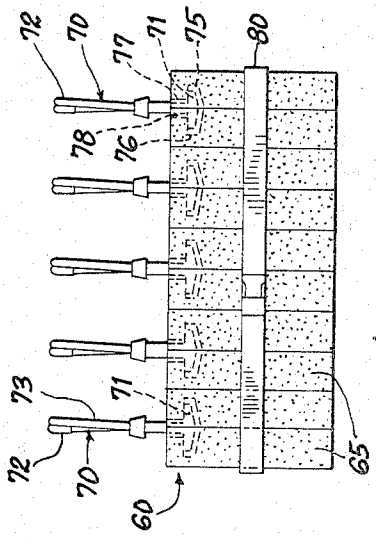

FIG. 8

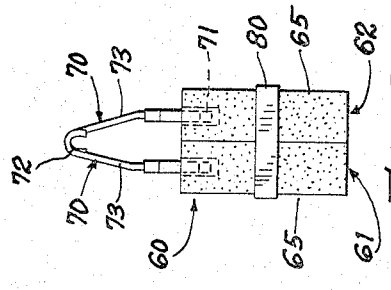

FIG. 9

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PANELIZED FURNACE ROOF

Filed June 11, 1965 4 Sheets-Sheet 2

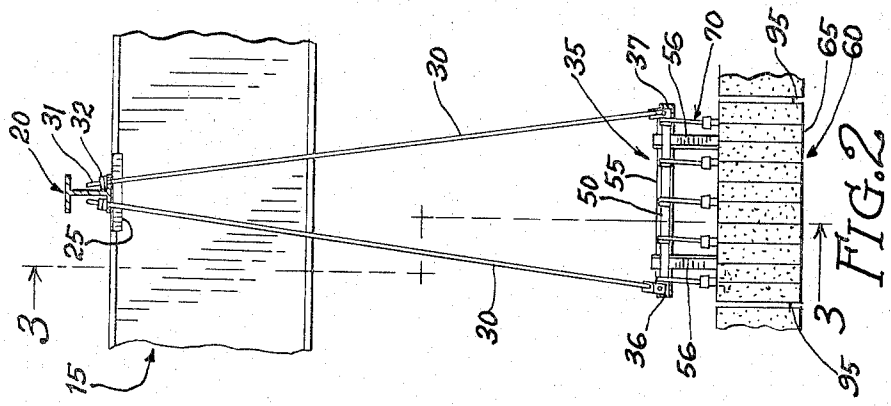

FIG. 2

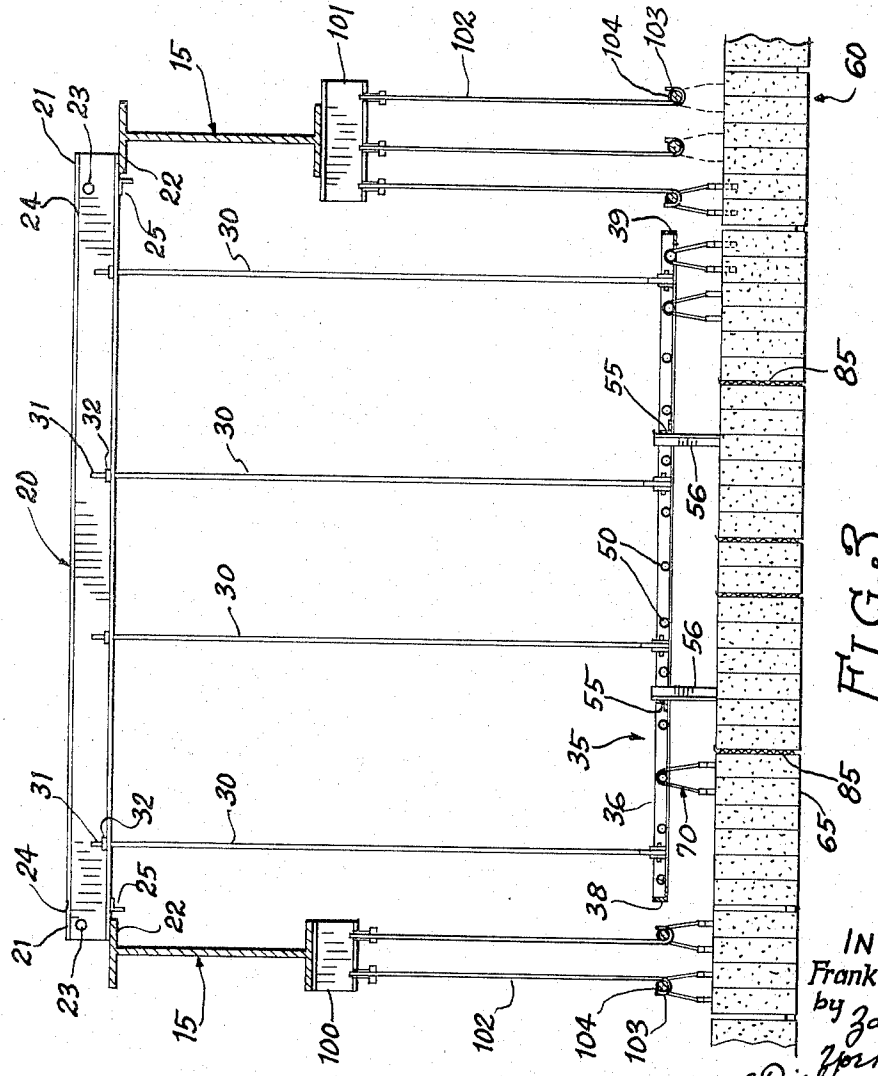

FIG. 3

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PANELIZED FURNACE ROOF

Filed June 11, 1965 4 Sheets-Sheet 3

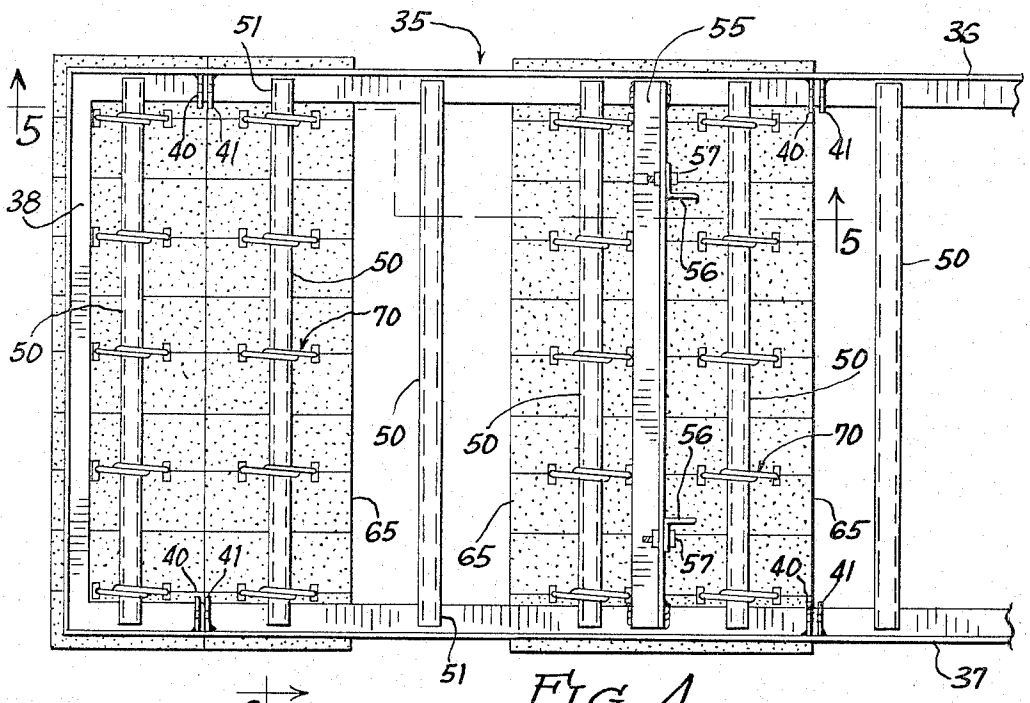

FIG. 4

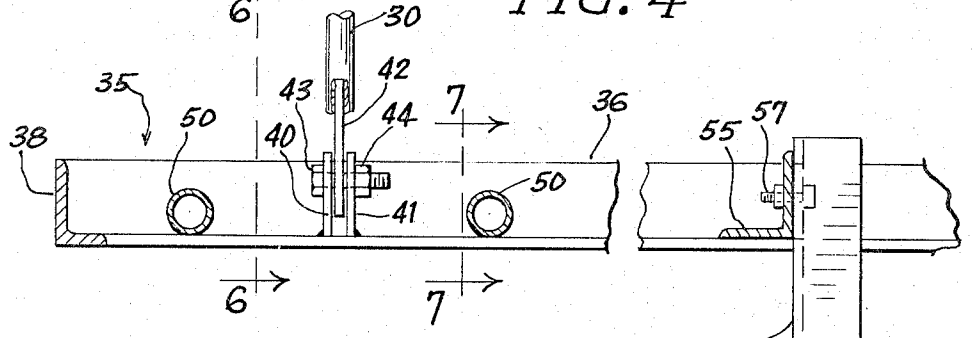

FIG. 5

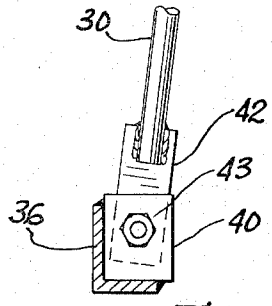

FIG. 6

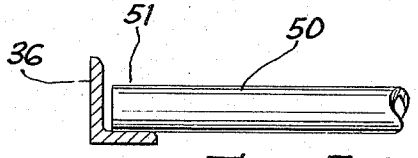

FIG. 7

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PANELIZED FURNACE ROOF

Filed June 11, 1965 4 Sheets-Sheet 4

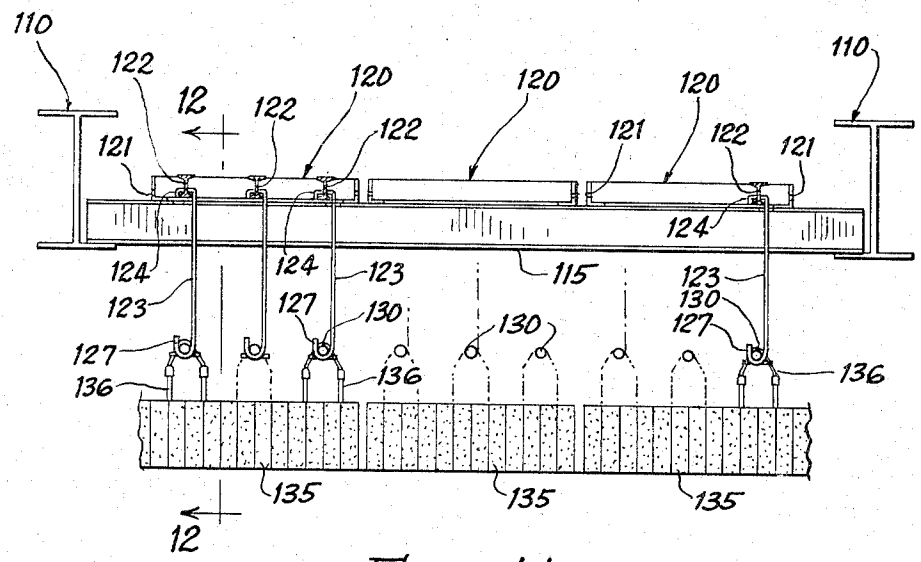

FIG. 11

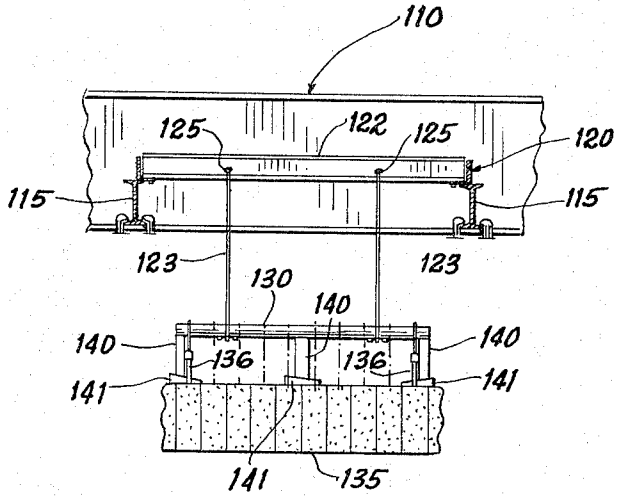

FIG. 12

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Patented Apr. 2, 1968

3,375,795

PANELIZED FURNACE ROOF

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Filed June 11, 1965, Ser. No. 463,081
9 Claims. (Cl. 110—99)

ABSTRACT OF THE DISCLOSURE

A panelized furnace roof characterized by a plurality of individual roof panels each separately movable vertically into and out of the furnace roof. Suitable support for the panels is provided. Each panel includes a rectangular frame, a plurality of laterally spaced parallel elongated members detachably carried by the frame, and a preassembled cluster of individually supported refractory bricks suspended from each elongated member. A brick cluster includes a flexible band means tightly encircling the bricks. The arrangement enables a comparatively large number of bricks to be installed and removed at once by vertical manipulation of an entire roof panel, and a smaller number of bricks by vertical manipulation of the bricks of the cluster. The invention provides important labor-savings by the brick manufacturer, the shipper, and the ultimate user in connection both with original installation and repair.

This invention relates to a furnace roof, and more particularly to a furnace roof made up of comparatively large roof panels. Each panel, in turn, includes preassembled clusters of individualy suspended refractory bricks.

Generally speaking, prior furnace roofs utilizing individualy suspended refractory bricks have been inordinately expensive, due largely to the considerable labor involved in installing the roof originally, and in making repairs to the roof during furnace operation. As is well known, furnace roofs often are repaired during furnace operation in order to avoid the increased expense that would result if the furnace were shut down and removed from operation during repair periods.

Further, the refractory bricks used in prior furnace roofs of the suspended type have required handling by the brick manufacturer and the customer more or less on the individual brick basis. Thus, labor is involved at the plant of the manufacturer to load the bricks on pallets for shipment to the customer. The bricks usually are stored on these pallets at the plant of the customer until needed.

When the time comes to install a new roof or make repairs in an existing roof, the loaded pallets are transported to the job site where the bricks are handled individually and inserted in the roof structure on a one or a two at a time basis.

In repairing a roof when the furnace is in operation, it has been customary to use at least two workmen at each repair station. These workmen cooperate with each other in removing deteriorated brick one or two at a time and replacing them with new brick on the same basis. Due to the high temperatures present, the workmen require relief every five or ten minutes, thereby making it necessary to have a second team of two workers available if the work is to be completed in the shortest possible time. The usual foreman increases the labor force to five, and there necessarily are one or two workmen at ground level handling the old and new bricks.

One object of the invention, therefore, is to provide a panelized furnace roof made up of integrated components which can be handled by manufacturer and customer, installed, removed and repaired with great savings of labor.

Another object is to provide a panelized furnace roof

wherein the refractory bricks are individually suspended and, at the same time, arranged in groups or clusters. These clusters, including the metallic hangers that suspend the brick, the associated hanger supports and in some cases the panel frames, are assembled at the plant of the brick manufacturer. As will be seen, the size of each brick cluster is such that a number of clusters makes maximum utilization of the conventional handling equipment (pallets, fork lift trucks, etc.) possessed by the brick manufacturer, the transportation agency and the ultimate customer. Thus, a maximum quantity of brick is able to be handled by a minimum amount of labor and without special equipment.

Still another object is to provide a panelized furnace roof wherein the refractory bricks may be installed, removed and replaced in various quantity, depending on the requirements of a particular job. Thus, by way of example, bricks may be installed, removed and replaced in groups of two, clusters of twenty, or panels of two-hundred and sixty. This feature, of course, serves to minimize the required labor, as well as to insure completion of a job in minimum time.

Other objects, advantages and details of the invention will be apparent as the description proceeds, reference being had to the accompanying drawings wherein a preferred form of the invention is shown. It is to be understood that the description and drawings are illustrative only, and that the scope of the invention is to be measured by the appended claims.

In the drawings:

FIG. 1 is a transverse sectional view through a furnace roof embodying the invention.

FIG. 2 is an enlarged transverse sectional view of a portion of the furnace roof shown in FIG. 1.

FIG. 3 is a longitudinal sectional view on line **3—3** of FIG. 2.

FIG. 4 is a fragmentary plan view of one of the panels of refractory brick used in the invention, certain parts removed for clarity.

FIG. 5 is an enlarged fragmentary sectional view, partly broken away, on line **5—5** of FIG. 4, showing details of the invention.

FIG. 6 is a fragmentary sectional view on line **6—6** of FIG. 5.

FIG. 7 is a fragmentary sectional view on line **7—7** of FIG. 5.

FIG. 8 is a side elevational view of a typical cluster of refractory brick used in the invention, the illustrated cluster having twenty bricks.

FIG. 9 is an end elevational view of the brick cluster shown in FIG. 8.

FIG. 10 is a top plan view of the cluster of FIG. 8.

FIG. 11 is a fragmentary longitudinal sectional view of a modified furnace roof embodying the invention.

FIG. 12 is a fragmentary sectional view on line **12—12** of FIG. 11.

Referring now to the drawings, FIGS. 1–3 show portions of an exemplary furnace roof embodying the invention. The illustrated roof may be either a new installation or a remodeled old installation, inasmuch as certain components are more or less conventional, thus indicating that the invention is suitable for use in either new or old furnaces.

A roof embodying the invention includes laterally spaced parallel pairs of primary girders **15** which, by way of example, may be 36 inch I-beams located on 12 foot centers. Girders **15** extend transversely of the furnace roof, and are supported at their ends by suitable columns or support means **16** (FIG. 1). Girders **15** and support means **16** are two components of the illustrated roof likely to be found in existing installations. Only one pair of primary

girders **15** and associated support means **16** are shown, but it will be understood that in the usual installation there will be a number of such primary girders and support means.

The invention also includes a plurality of laterally spaced parallel secondary girders **20**, here shown as I-beams, that extend transversely between primary girders **15** and longitudinally of the furnace roof. End portions **21** (FIG. 3) of secondary girders **20**, as shown, rest on upper surfaces or flanges **22** of primary girders **15**. As will be seen, a secondary girder **20** and the parts associated therewith, presently to be described, are such that they may be installed, removed and replaced as a unit by means of a crane or other hoisting device.

Each secondary girder **20** is provided with some means for attaching chains or the like from a hoisting device. In the form of the invention shown, end portions **21** of a secondary girder **20** have hook-receiving openings **23**, and it will be noted that the adjacent upper flanges of the girder are cut away as shown at **24**.

Suitable means are provided for centering secondary girders **20** transversely with respect to the space between a pair of primary girders **15**, and, as shown in FIG. 3, such means may take the form of angle irons **25** welded on the lower flanges of girder **20** near the ends. Alternatively, similar flanges could be welded centrally on the upper surfaces of primary girders **15**. Such flanges, of course, aid in properly positioning girders **20** and insure that they will be retained in desired position.

Referring particularly to FIGS. 2 and 3, each secondary girder **20** is provided with a plurality of spaced pairs of downwardly extending supporting rods **30**. Four such pairs are shown in the illustrated form of the invention. The upper ends of rod **30** are secured to a secondary girder **20** in suitable manner, and, as shown, they extend through openings in the lower flange of the girder. The rod ends are threaded at **31** and provided with holding nuts **32**, making rods **30** easy to install, remove and replace. As shown in FIG. 2, the rods **30** of each pair diverge in downwardly direction.

A rectangular frame **35**, best shown in detail in FIGS. 4–7, is carried in a horizontal plane by the lower ends of supporting rods **30**. The length of frame **35** is slightly less than the length of a secondary girder **20**, as shown in FIG. 3, and the width of the frame is related to the length of the brick clusters that will be described later.

In the form of the invention shown, rectangular frame **35** advantageously is made up of four angle irons suitably welded or otherwise secured together at the corners. Thus, angle irons **36** and **37** constitute the longer sides of the frame, and angle irons **38** and **39** constitute the shorter sides. One flange of each angle iron **36–39** preferably is lowermost with the other flanges of the angle irons defining the frame periphery. The advantage of this arrangement will be mentioned presently.

Referring to FIGS. 5 and 6, the longer angle irons **36** and **37** are provided at spaced intervals with pairs of closely spaced plates **40** and **41** welded at right angles to the flanges. Corresponding plates on the two angle irons are located in transverse alignment, and they serve to anchor to frame **35** the lower ends of the pairs of downwardly extending supporting rods **30**. As shown in FIGS. 5 and 6, a plate **42**, welded or otherwise secured to the lower end of each supporting rod **30**, is disposed between plates **40** and **41** on the angle irons. A bolt **43** extends through aligned holes in the three plates, and a nut **44** secures the bolt in position. Other arrangements for attaching rods **30** to frame **35** are, of course, possible.

A plurality of laterally spaced parallel elongated members **50**, here shown as pipes, are carried by and extend transversely of frame **35**. End portions **51** of members **50** (FIGS. 4 and 7) rest loosely on lowermost flanges of the longer frame angle irons **36** and **37** and are limited in endwise movement by the peripheral flanges of the angle irons. Members **50**, as will be seen, support clusters of refractory brick that will be described later.

A pair of spaced members **55** (FIGS. 2–5), here shown as angle irons, extend transversely of and are secured to frame **35** as by welding. Members **55** are so located in frame **35** that they will be positioned between pairs of elongated members **50**, as best shown in FIGS. 3 and 4. Vertical members **56**, here also shown as angle irons, are secured detachably as by bolts **57** (FIG. 5) to transverse members **55** near the ends thereof when frame **35** is assembled with the brick clusters next to be described. Vertical members **56**, as will be seen, serve as spacer members to maintain frame **35** in assembled relation with the brick clusters.

One of the several preassembled brick clusters **60** used in the invention is shown in detail in FIGS. 8–10. As mentioned, brick clusters **60** desirably are fabricated by the brick manufacturer and shipped to the customer in preassembled form.

The illustrated cluster **60** comprises two side-by-side rows **61** and **62** of refractory bricks **65** having an even number of bricks in each row. Each pair of adjacent bricks in each row is supported by an elongated metallic hanger member **70** that has a lower end **71** of inverted T-shape and a hook **72** at the upper end. The intermediate portion **73** between lower end **71** and hook **72** may be rod-like.

Each pair of adjacent bricks in a row, in the illustrated form of the invention, has more or less conventional opposing horizontal recesses **75** and **76** (FIG. 8) spaced from the upper brick ends, and opposing vertical recesses **77** and **78** connecting the horizontal recesses with the upper brick ends. The inverted T-shaped lower end **71** of a hanger member **70** is received within the recesses, as shown in FIG. 8, and serves to support the two bricks of a pair. Other arrangements for supporting the bricks from hooked hangers are possible, of course, and are within the scope of the invention.

The illustrated cluster **60** has two rows of ten bricks each, with five hanger members **70** in each row. It has been found that this is a convenient size for a cluster, but obviously the advantages of the invention are not based on this precise size.

Corresponding pairs of bricks **65** in the two rows **61** and **62** are in lateral alignment. Similarly, the hanger members **70** of these two pairs also will be in general alignment, as shown in FIGS. 8 and 10. The hanger members **70** of each pair converge upwardly toward each other as shown in FIG. 9, with hooks **72** thereof in general alignment.

A band of flexible material **80** (enlarged on drawing for clarity), such as steel strapping, tightly encircles the bricks, and maintains the bricks and hangers of a cluster in assembled relation. Flexible material **80**, incidentally, may remain on the cluster after the latter is installed in a furnace roof. Eventually, of course, material **80** burns away.

A standard transport and storage pallet of the size customarily used by brick manufacturers and customers readily accommodates five brick clusters **60** of the size and shape shown. Loaded pallets of such size are handled conveniently by a conventional fork lift truck, and easily may be loaded for shipment on the top of a shipment of wall and hearth brick going to the same customer. This economical shipping technique is applicable when the brick clusters are intended for a new furnace installation which also requires quantities of brick for other parts of the furnace.

When quantities of brick clusters **60** are shipped in the absence of other brick, as is often the case for repair purposes, they advantageously are positioned on pallets on edge in opposing relation with other brick clusters, whereby the hanger members **70** of opposing clusters interfit.

Brick clusters **60** ordinarily are assembled in frame **35** at the job site. The frame **35** shown in FIG. 3 is of such

size as to accommodate thirteen clusters **60**. If an entire panel comprising a frame **35** and thirteen clusters is to be assembled, as in the case of a new installation or a major repair, the thirteen new clusters **60** are arranged side-by-side on the floor adjacent the furnace. A secondary girder **20**, including supporting rods **30** and frame **35**, is lowered by means fo a crane or other hoisting device, the frame positioned in alignment with and slightly above the brick clusters. An elongated member **50** is threaded through hooks **72** of hanger members **70** of each cluster, and positioned on the lowermost frame flanges. Thereafter, girder **20** is lifted and placed in proper position in the furnace roof, the end portions **21** of secondary girder **20** resting on the upper surfaces of spaced primary girders **15**, as shown in FIG. 3.

When a frame **35** is assembled with clusters **60** and not immediately installed in a roof, the previously mentioned vertical spacer members **56** are secured to transverse frame members **55**. The lower ends of the vertical members engage some of the bricks in clusters **60** and support frame **35** above the clusters.

Still referring to FIG. 3, corrugated metal plates **85**, or other joint members permitting brick expansion, are positioned between some of the adjacent brick clusters. Four such expansion plates or members are shown in the illustrated panel.

In view of minor dimensional irregularities in the bricks, it is desirable that elongated pipe members **50** do not have definitely fixed positions longitudinally of frame **35**. Adequate positioning of members **50** in frame **35** is afforded by the limited clearance which exists between hooks **72** on hanger members **70** of the end brick clusters and angle irons **38** and **39** at the ends of frame **35**, as shown at **90** at the right in FIG. 3.

Expected expansion at the longer sides of a panel is compensated for by the use of members **95** (FIG. 2) which may take the form of wood strips. These strips, of course, burn away during furnace operation, and permit longitudinal expansion of the brick clusters.

Referring again to FIG. 3, it will be remembered that the length of a panel must be somewhat shorter than the spacing between primary girders **15** so that the panel may be lowered and lifted vertically between the girders. Thus, the furnace roof portion directly below primary girders **15** may not be supported by secondary girders **20** and associated frames **35**.

This portion of the furnace roof, as shown only in FIG. 3, includes girder portions **100** (at left) and **101** (at right) secured to the lower surfaces of primary girders **15**. Spaced pairs of supporting rods **102** extend downwardly from girders **100** and **101**, and hooks **103** at the lower ends of the rods serve to support elongated members **104** that in turn support brick clusters **60**. These clusters **60**, or the bricks therein, are manipulated individually during installation and repair.

The illustrated primary girders **15** and secondary girders **20** are representative of supporting structure in new and existing suspended furnace roofs, and are intended to be exemplary. It is apparent that other specific arrangements of primary and secondary girders are possible.

The modified form of the invention shown in FIGS. 11 and 12 illustrates another specific arrangement of primary and secondary girders, as well as variation in the relationship between the rectangular frames and the associated brick clusters that constitute the roof panels. This form shows the extreme flexibility of the invention and the changes that easily may be made to utilize the illustrated existing primary and secondary girders in a roof embodying the invention.

Referring to FIG. 11, laterally spaced primary girders **110** extend transversely of the furnace in the manner of the previously described girders **15**. Laterally spaced secondary girders **115** extend longitudinally of the furnace betwen primary girders **110**. These secondary girders **115**, in accordance with the existing arrangement, rest on the lower flanges of primary girders **110** and thus, due to the top flanges above, may not be removed easily. In contrast, secondary girders **20** of the form first described rest on the top flanges of the primary girders, and are easily removable.

Each roof panel, as in the previous form, includes a rectangular frame **120** preferably constructed with angle iron members having one flange lowermost and the other flange on the frame periphery. These frames **120** rest loosely on secondary girders **115**, and each may be lifted out of the furnace roof when it is desired to remove and replace a complete panel. Opposed frame members may have suitable means, such as apertures **121**, for engagement by hooks on hoisting chains when a panel is to be manipulated.

In the panels shown, laterally spaced tertiary girders **122** extend longitudinally of frames **120** and rest loosely on the lower flanges of opposed frame members. A tertiary girder **122**, as will be seen, may be removed individually from the panel when it is desired to make repairs in the group of bricks supported by such girder.

Each tertiary girder **122** carries two or more downwardly extending supporting rods **123**. A rod **123** has a hook **124** at its upper end which is received within an opening **125** (FIG. 12) in the tertiary girder. As shown, girder **122** is an I-beam, and openings **125** are located in the beam web.

The lower end of a supporting rod **123** has a hook **127**, as best shown in FIG. 11. The lower hooks **127** of the two or more supporting rods **123** associated with a tertiary girder **122** detachably carry an elongated member **130**. Elongated members **130** may be pipes of the same character as elongated pipe members **50** used in the first form of the invention.

Each elongated member **130** carries a plurality of bricks **135** in cluster assembly. The brick clusters may be the same as the brick clusters previously described, or they may have modified form as shown in FIGS. 11 and 12.

The exemplary brick arrangement shown in FIGS. 11 and 12 may constitute a single brick cluster of four bricks in width and ten bricks in length, or two brick clusters each two bricks in width and ten bricks in length. The flexible bands or the like which encircle the brick clusters and hold the bricks in assembled relation are omitted in FIGS. 11 and 12, but it is understood that a holding band will be used with each brick cluster.

Bricks **135** are suspended from elongated members **130** by hanger members **136** which, in the form shown, have lower ends that supportingly engage the bricks and upper ends that detachably hook onto members **130**.

When the brick clusters are preassembled with elongated members **130**, spacer members such as struts **140** (FIG. 12) and associated wedges **141** extend in combination between elongated members **130** and some of the bricks **135**. Such spacer members are effective to maintain fixed relation between an elongated member and associated bricks prior to mounting the cluster in a roof panel.

In the form of the invention shown in FIGS. 11 and 12, bricks requiring may be removed and replaced on a one or two at a time basis, on a twenty or forty at a time basis (depending on the size of the clusters used) or on the basis of a complete panel, that is, the number of bricks carried by a removable rectangular frame.

From the above description it is thought that the construction and advantages of this invention will be readily apparent to those skilled in the art. Various changes in detail may be made without departing from the spirit or losing the advantages of the invention.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A panelized furnace roof comprising:

a laterally spaced parallel pair of fixed primary girders;

a plurality of roof panels detachably carried by said primary girders, each roof panel including,

a rectangular frame;

a plurality of laterally spaced parallel elongated members detachably carried by said rectangular frame; and

a preassembled cluster of individually supported refractory bricks suspended from each elongated member, said cluster including flexible band means tightly encircling said bricks,

the size of each roof panel such that the entire panel is movable vertically into and out of the furnace roof without interference by said primary girders;

whereby a comparatively large number of bricks may be installed and removed at once by vertical manipulation of an entire roof panel, and a smaller number of bricks may be installed and removed at once by vertical manipulation of the bricks of a cluster.

2. The combination of claim **1** with the addition of laterally spaced parallel secondary girders extending transversely between and resting on said primary girders, said rectangular frames carried by said secondary girders.

3. The combination of claim **1** wherein each rectangular frame is formed of angle irons positioned with one flange of each lowermost and the other flanges defining the frame periphery.

4. The combination of claim **3** wherein end portions of said elongated members rest loosely on lowermost flanges of said rectangular frames and are limited in endwise movement by peripheral flanges of said frames.

5. The combination of claim **2** with the addition of downwardly extending supporting rods carried by each secondary girder, the lower ends of said supporting rods connected to one of said rectangular frames.

6. The combination of claim **5** wherein said secondary girders each have flange portions, and wherein the upper ends of said supporting rods extend through openings in said flange portions, said upper ends threaded and having retaining nuts thereon.

7. The combination of claim **1** wherein each preassembled cluster of refractory bricks comprises side-by-side rows of bricks and means individually supporting said bricks.

8. The combination of claim **1** wherein each preassembled cluster of refractory bricks comprises side-by-side rows of bricks and a plurality of metallic hanger members each supportingly engaging at least one brick, the upper end of each hanger member having a hook detachably engaging one of said detachable elongated members.

9. The combination of claim **2** wherein said rectangular frames rest on said secondary girders, with the addition of spaced parallel tertiary girders extending lengthwise of said frames, end portions of said tertiary girders resting loosely on said frames, and downwardly extending supporting rods, the upper ends of said supporting rods connected to said tertiary girders and the lower ends of said supporting rods connected to said cluster-carrying elongated members.

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