

Sept. 16, 1941.

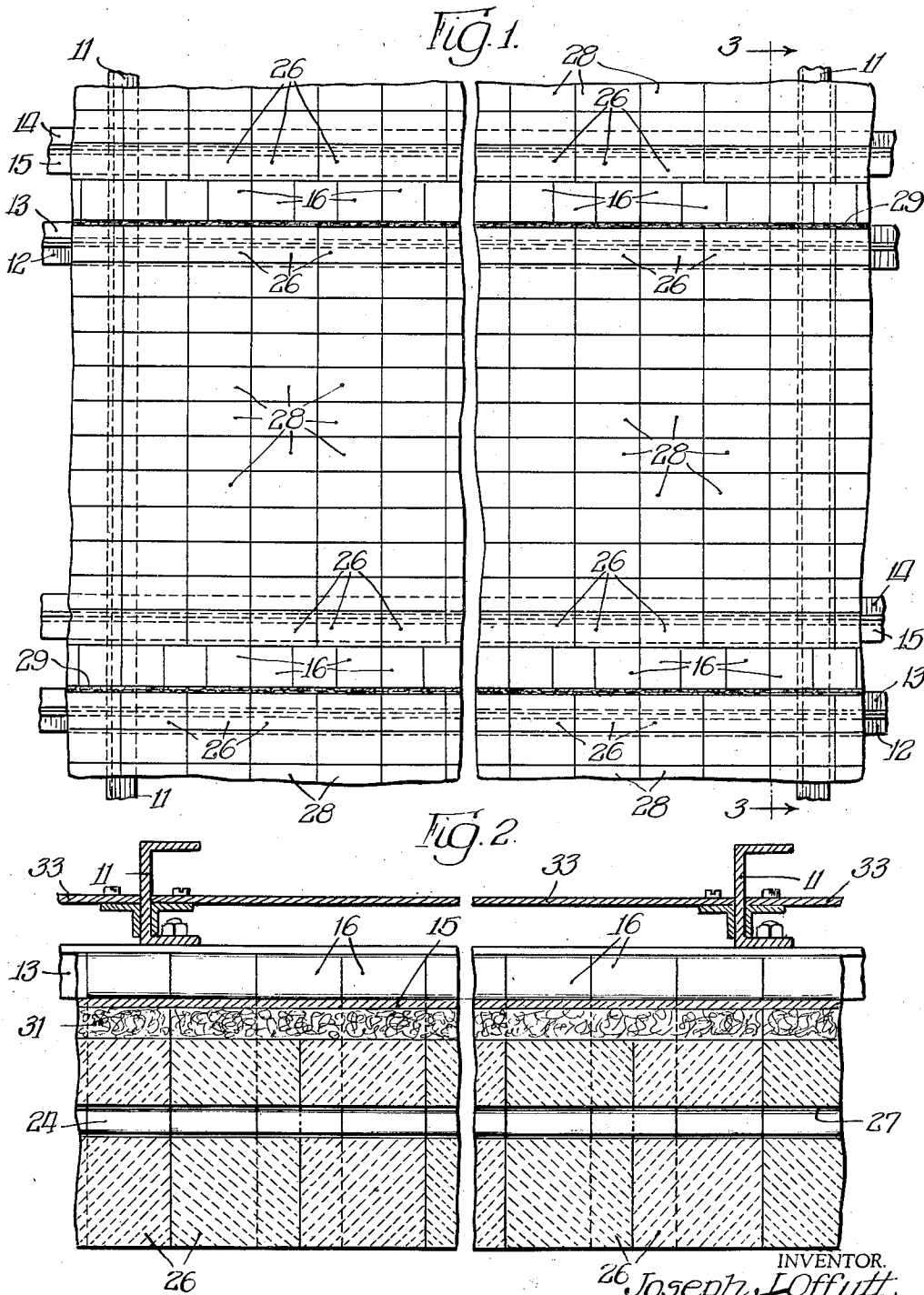
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2,255,803

FURNACE WALL

Filed Jan. 2, 1941

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Fig. 3

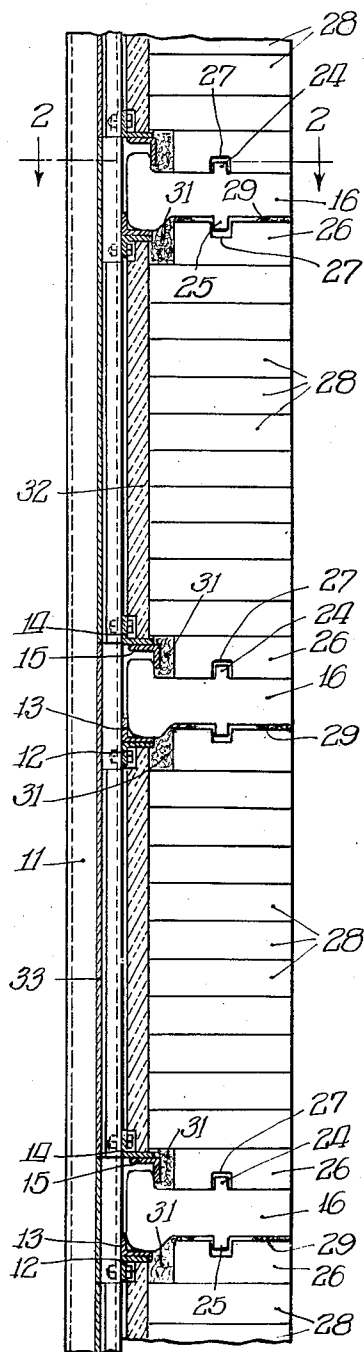


Fig. 4

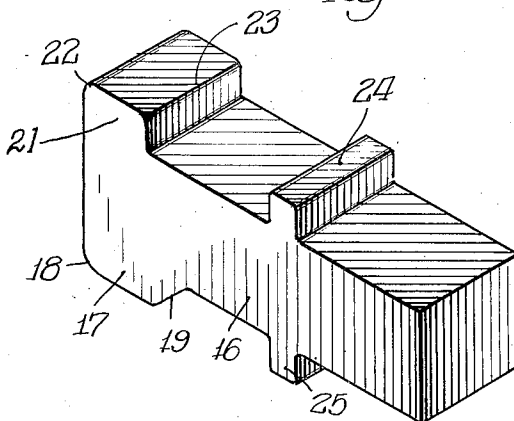


Fig. 5

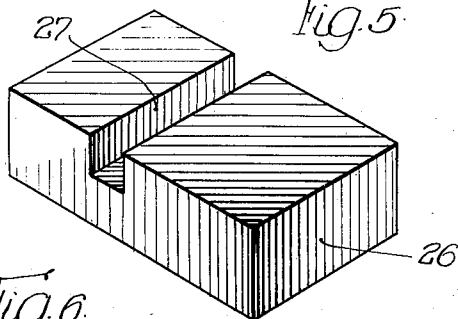
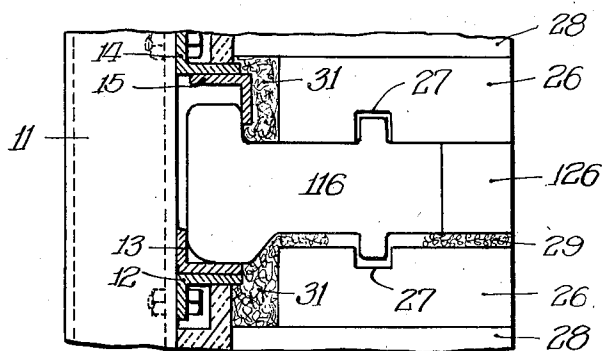


Fig. 6



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2,255,803

FURNACE WALL

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17 Claims. (Cl. 72-101)

The present invention pertains to certain betterments and advantages accruing from novel structural and functional features in furnace-walls and the like, the instant invention involving a sectional-wall, each section of which includes a row of refractory-firebricks on which is mounted a group, a series or tiers of well-known light-weight insulating-firebricks.

Present preferred embodiments of the invention, as illustrated in the accompanying drawings, forming a part of this specification, will be first described in detail and some of the more important benefits accruing from their employment will be thereafter indicated.

In these drawings, in which like parts are supplied with the same reference numerals:

Figure 1 is a face-view of a small part only of one of the novel walls as viewed from the inside of the furnace;

Figure 2 is a horizontal sectional view on line 2-2 of Figure 3;

Figure 3 is a vertical sectional view on line 3-3 of Figure 1;

Figure 4 is a perspective-view of one of the supporting refractory-firebricks;

Figure 5 is a perspective-view of one of the special insulation-firebricks; and

Figure 6 is a small, vertical sectional view through a slightly modified style of wall and on a somewhat larger scale than that of Figure 3.

Referring to these drawings, it will be noted that one style of the new and improved furnace-wall includes upright, appropriately-supported columns or buck-stays 11, 11 spaced apart suitable distances depending upon the wall-structure involved.

Mounted against the inner faces of such supporting columns as by riveting, welding, bolting or otherwise, are a series of pairs of united, vertically-spaced, companion angle-bars 12, 13, the one bar having its flange against the columns disposed downwardly, whereas its mate has its corresponding flange projecting upwardly, the two inwardly-extended flanges of the pair bearing against, and reinforcing, one another. If desired, these angle-bars may be welded to one another thereby forming a unitary sustaining-bar, their inwardly-directed flanges constituting a shelf or ledge as will be readily understood.

Spaced a suitable distance above each such pair of angle-bars 12, 13 is another horizontal pair of angle-bars 14, 15, unitedly providing a retaining-bar, of which the one bar 14, with one flange arranged upwardly, is secured in any appropriate manner against the same surfaces of

the columns, its inwardly-projecting flange having one flange of the second angle-bar 15 fastened thereto as shown, and its other flange disposed downwardly inwardly away from the columns, the two horizontal flanges of the mating bars being secured together as by welding. In this case, the bar 14 carries the bar 15 and all of the four bars tie the columns together, as will be easily perceived.

Thus the upright and horizontal bars divide the frame and the completed wall into rectangular sections, each defined by the spaced columns and the welded-together angle-bars 12-13.

By means of each set of such angle-bars 12-13, 14-15, a horizontal row of refractory-firebricks 16 is mounted directly on the indicated metallic-framework, each such brick or block at its outer end having a downwardly extended rib 17 occupying the full width of the brick and having a curved surface 18 at the lower transverse edge of the brick and another transverse sloping or inclined surface 19 under the body of the brick.

Across the full width of the top of the outer end of such brick, it has a cross rib or projection 21 preferably with rounded corner edges 22, 23.

The inner end of the brick is flat, as is also both of its side surfaces, its top and bottom faces, except for the parts 17 and 21 already referred to, being plane, parallel surfaces, except that each, at about the middle of the length of the brick, has a cross-rib 24 and 25 respectively, occupying the full width of the brick, these upper and lower ribs 24 and 25 being preferably, but not necessarily, in vertical register.

Each such brick of the row may be readily mounted on the framework by tilting it upwardly inwardly, introducing the top portion of the outer end of the brick between the two sets of angle-bars, and then rocking the brick downwardly to horizontal position while at the same time advancing it outwardly, with the final result that the outer part of the brick is properly seated on the ledge or shelf of the angle-bar 13 while its projection 21 bears against the outer surface of the depending flange of the angle-bar 15, whereby the brick is adequately supported in horizontal position from its outer portion only, these relatively-strong refractory-firebricks actually contacting with only two of the four angle-bars.

A row of such refractory-firebricks, or sufficient thereof to provide for one section of the wall, having been mounted on the framework in the manner indicated, a course of light-weight, insulating-firebricks 26 is superposed directly on the inwardly-extended part only of the support-

ing-bricks 16, each brick 26 being of rectangular parallelepiped shape except that its under surface has a cross-groove 27 somewhat loosely accommodating the rib 24 of bricks 16, each such brick 26 terminating short of the angle-bar 15 and its top surface being slightly above the upper face of the horizontal flange of angle-bar 14, such a brick 26 being shown in inverted position in Figure 5.

The remainder of the superimposed courses of insulating-firebricks 28, 28 of the group or vertical series are of the same shape as brick 26, but they are ungrooved and are somewhat longer thereby extending outwardly to a greater extent, the inner ends of bricks 26 and 28 being substantially flush with one another.

The bricks 26 of the top course of the series are like the one referred to, save that they are used upside down, so that their grooves 27 will partially accommodate the ribs 25 of the refractory-firebricks 16 immediately above, a suitable expansion space being provided between such bricks 26 and 16 which gap, as well as those at the outer ends of bricks 26 may be filled with fibre-asbestos or other appropriate filling 29 and 31 which will allow all of the brick-wall sections to expand and contract independently of one another and of the metal framework.

Block or other suitable insulation 32 may be used between the insulation-firebrick portions of the wall and the framework and may rest upon and be supported by the angle-bars 14 as portrayed in the drawings.

Outside of such insulation, each section of the wall may be covered with a sheet-metal panel-plate 33 coextensive with the area of the wall-section and readily-demountably fastened to the framework in any approved or satisfactory manner so that it may be temporarily taken off for repair of the wall and replaced with facility.

Because all insulating-firebricks are materially weaker in physical strength than are the heavy refractory-firebricks, it is desirable to eliminate or avoid cumulative loading of the former, particularly in relatively-high furnaces, and, accordingly, in the present construction, each section of the wall is not only independently supported, but is limited as to height, being four feet high, although, of course, this is subject to substantial variation.

Weighty refractory-firebricks in general have a modulus of rupture of from 350 pounds to 1500 pounds per square inch with an average of around 800 pounds to 900 pounds, whereas, the insulating-firebricks employed have a corresponding modulus of 80 pounds to 250 pounds per square inch, the exact specified figures being somewhat approximate.

Light-weight insulating-firebricks have nearly the same coefficient of thermal-expansion as that of the heavy refractory-firebricks, this in each instance frequently being as much as $\frac{1}{8}$ of an inch per foot at a maximum temperature reached which is approximately 2000° F., and, because of this, means are provided in the wall-construction to permit such expansion to take place without imposing undue strain on either the materials of the wall or on the supporting metal-framework.

The insulating-firebricks employed in the wall design should preferably have a density of not more than 70 pounds per cubic foot and the conductivity of such bricks should desirably be within the range of $1\frac{1}{2}$ to $3\frac{1}{2}$ B. t. u. per square foot per inch thickness per degree Fahrenheit dif-

ference in temperature at a mean temperature of 1000° F., this corresponding to a density of about 120 to 160 pounds per cubic foot and a conductivity of approximately 7 to 9 for the heavy refractory-firebricks.

Any type of block-insulation may be used with satisfaction back of the insulation-firebricks and any conventional thickness of such insulation will function reasonably well, but it is considered that under ordinary circumstances the block-insulation will not be more than 4 inches thick. Due to the irregular space between the supporting steel members of the framework and the insulation-firebricks, a loose fill consisting mainly of long fibre asbestos is used to reduce heat losses through the wall and to hold the temperature on the supporting steel to a minimum.

The insulation-firebricks are laid up in high-temperature air-setting bonding-mortar which, when dried at room temperature, develops a bond strength as high as that of the bricks, so that in effect the panel of insulation-firebricks is really a single unit.

Special plastic fire-clay is employed in laying up the supporting refractory-tiles which does not bind the tiles together so that each is free to move independently which is always desirable where tiles are individually supported.

Again, a fire-clay joint is used on the upper face of the supporting-firebricks because no bond is effected, this being of advantage because it is intended that the insulation-firebrick sections and the supporting-firebricks shall be free to move independently of one another at all times.

Long-fibre asbestos is employed in all expansion-joints to act as a seal against any possible leakage through the wall.

The heavy fire-clay bricks or tiles 16 constituting the supporting-members in the present design were developed with the particular idea in mind of obtaining maximum strength, actual breakage tests consisting of loads applied just as they are in service indicating the supporting-blocks as capable of carrying a 9 inch insulating-firebrick wall more than 80 feet high, such wall seldom being employed thicker than 9 inches and in thinner walls the supporting-firebricks are even stronger. Since it is not expected that wall-sections will often be more than 4 feet high, even in the 9 inch wall referred to, the supporting or sustaining firebricks afford a strength safety factor of more than 20 to 1, such factor applying in the service indicated because the tiles or bricks are supported at their outermost parts where temperatures will never become high enough to cause a weakening of either the tiles or bricks or of the supporting steelwork.

The lugs or ribs on both the top and bottom surfaces of the sustaining tiles or bricks serve as anchors for the insulation-firebrick sections, preventing undue buckling, distortion or other lateral movement of the wall-section, these ribs also serving to provide offset joints at the tops where the fire-clay joint is used and at the bottom where an expansion-joint exists.

Another feature of the new wall, which will be readily appreciated, is the fact that it is simple in structure and therefore economical to produce and to service, the design being so free from any features of complexity that once the supporting steel-members have been properly installed, the sustaining refractory tiles or bricks for a panel can be readily inserted in place without further fitting, whereupon the superimposed insulating-

firebricks may be laid up as in a normal vertical wall.

Again, only two special shapes of bricks, in addition to the standard insulating-bricks, are required in the novel design, one of these being the sustaining tile or brick 16 made of regular or ordinary fire-clay, the other being the special insulating-firebricks 26 used in the courses just above and immediately below the row of refractory fire-clay sustaining members 16, these bricks being cut from standard insulating-bricks to provide the groove 27.

The steel of the framework is of the lightest and most economical kind, being standard steel structural shapes and such parts may be of small or limited weight, because they are all at the outside of the wall where temperatures are never excessive.

In most insulating-firebrick walls, the supporting-means comprises comparatively-heavy steel angle-bars projecting in part into the brick-wall with the result that the innermost portions of such metal members become quite hot in service requiring that they be made of an expensive heat-resisting alloy, which relatively high cost is avoided in the present new design of wall.

In many insulating-firebrick wall designs, it is customary for anchors, welded to the steel-shell, to tie into the bricks, and, whereas such anchoring-means prevents buckling and lateral movement, it hinders free movement of the wall in vertical and horizontal planes, which action occurs each time the wall is heated and cooled.

Most sectionally-supported, insulating-firebrick walls can be repaired from the inside of the furnace, but an important feature of the wall incorporating the present invention is the fact that any insulating-firebrick section can be repaired either from the inside or from the outside of the furnace without disturbing any of the surrounding or neighboring sections.

Known wall designs involve readily-removable metal-panels so that a complete section of refractories and steel-shell on which they are mounted can be removed, then rebuilt, and thereupon reinserted in place, and whereas such a method of repair appears easy of accomplishment until actually attempted, it is soon discovered that it is troublesome in the field due to the large size of the unit to be handled and because of the accurate fit required for satisfactory results.

In the present new structure, the insulating-firebricks are not anchored to the shell, assuming that the wall is provided with a sheet-metal casing divided into removable panels, in which case any section of the steel-casing can be removed freely and easily and then the corresponding portion of the insulation taken out, after which the insulation-firebrick wall-section can be broken loose and removed in convenient size pieces, the repair then being effected and involving nothing more than ordinary brick-laying, which will be a little slower when performed from the outside, but still a very simple operation, and the insulation and the sheet-panel can be replaced thereafter.

Because the heat conductivity of the heavy, strong refractory-blocks 16 is about four times as great as that of the insulating-firebricks, one might naturally assume that the use of such sustaining-bricks mounted directly on the metal framework would normally decrease the efficiency of the wall by permitting a high rate of heat flow through such sustaining-bricks, but tests

have demonstrated that such is not the case, since the method of insulation and design of the wall result in heat losses averaging very little more than those of a similar wall with no such sustaining-means.

The new-fashioned wall is more efficient than competitive insulating-firebrick walls because of the extremely-rapid heat-drain through the supporting steel-angles of the latter; and, even though these angles extend only about half way through the wall, the heat conductivity through the steel is so much greater than through the firebricks that the heat loss through the steel support exceeds that through the sustaining-bricks of the instant structure, even though such bricks are larger in cross-sectional area and extend through to the inner surface of the wall.

In some instances, it may be desirable and feasible to employ small, insulating-firebricks at the inner ends of the sustaining refractory-firebricks 16 as a protective measure with relation to the exposure of the latter to the direct heat in the furnace and such a construction is shown fragmentarily in Figure 6, wherein such supplemental brick is designated by the reference numeral 126 and the somewhat shortened sustaining-brick characterized as 116.

Those acquainted with this art will readily understand that the present invention as defined by the appended claims is not necessarily limited and restricted to the precise and exact details of structure illustrated and described and that various modifications may be resorted to without departure from the heart and essence of the invention and without the loss or sacrifice of any of its material benefits and advantages.

I claim:

1. A refractory-firebrick having a first upstanding transverse rib across the top surface of the outer end of the brick, a second upstanding transverse rib across the top surface of the brick intermediate its inner and lower ends, a third downwardly-extended transverse rib across the bottom surface of the brick at its outer end, and a fourth downwardly-extended transverse rib across the bottom surface of the brick intermediate its inner and outer ends.

2. The refractory-firebrick set forth in claim 1 in which the lower outer edge portion of said third rib is rounded off and in which the inner surface of such third rib is inclined to the main bottom surface of the brick.

3. In a sectional furnace-wall having upright columns, horizontal metal sustaining-bars mounted in vertically-spaced relation on said columns, horizontal metal retaining-bars mounted in vertically-spaced relation on said columns, each such retaining-bar being complementary to and located above one of said sustaining-bars and having a depending portion, said columns and bars defining the sections of the wall, vertically-spaced rows of supporting-firebricks each row bearing on and supported by one of said sustaining-bars and maintained in place thereon by engagement with said portion of the companion retaining-bar, and superimposed courses of supported-firebricks between successive rows of said supporting-firebricks, the novel combination of features being (a) that said supporting-firebricks are refractory-firebricks having a modulus of rupture of from approximately 350 pounds to approximately 1500 pounds per square-inch, (b) that the majority of said supported-firebricks of said courses are light-weight insulation-firebricks having a modulus of rupture of from ap-

proximately 80 pounds to approximately 250 pounds per square-inch, (c) that said refractory-firebricks are supported on said sustaining-bars by the outer end portions only of said firebricks, (d) that said courses of supported-firebricks are upheld solely by the parts of said rows of refractory-firebricks extended inwardly of the furnace beyond their sustaining and retaining bars, and (e) that each said set of courses of said supported-firebricks extend upwardly from its supporting row of refractory-firebricks to the next upper row of such refractory-firebricks.

4. The novel combination of features in furnace-walls set forth in claim 3 in which the modulus of rupture of said refractory-firebricks is from approximately 800 pounds to approximately 900 pounds per square-inch.

5. The novel combination of features in furnace-walls set forth in claim 3 in which all of the supported-firebricks are of the specified light-weight insulation type.

6. The novel combination of features in furnace-walls set forth in claim 3 in which each row of said supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of supported bricks immediately above and directly below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row.

7. The novel combination of features in furnace-walls set forth in claim 3 in which each row of said supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of supported bricks immediately above and below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row, and in which the bricks of said above and below rows have a dimension corresponding to the thickness of the wall less than that of the other courses of supported-firebricks.

8. The novel combination of features in furnace-walls set forth in claim 3 in which all of the supported-firebricks are of the specified light-weight insulation type, in which each row of said supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of the light-weight insulation-firebricks supported immediately above and below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row, and in which the bricks of said above and below rows have a dimension corresponding to the thickness of the wall less than that of the other courses of supported-firebricks.

9. The novel combination of features in furnace-walls set forth in claim 3 in which the outer end portion of each said supporting refractory-firebrick has a transverse rib upstanding from the top surface of the brick and has a transverse rib projecting downwardly from the under surface of the brick, the lower outer edge portion of said second rib being rounded off and the inner surface of said second rib being inclined upwardly inwardly of the furnace to the main bottom surface of the brick.

10. In a sectional furnace-wall having upright columns, horizontal metal sustaining-bars mounted in vertically-spaced relation on said

columns, horizontal metal retaining-bars mounted in vertically-spaced relation on said columns, each such retaining-bar being complementary to and located above one of said sustaining-bars and having a depending portion, said columns and bars defining the sections of the wall, vertically-spaced rows of supporting-firebricks each row bearing on and supported by one of said sustaining-bars and maintained in place thereon by engagement with said portion of the companion retaining-bar, and superimposed courses of supported-firebricks between successive rows of said supporting-firebricks, the novel combination of features being (a) that said supporting-firebricks are refractory-firebricks of a density of from approximately 120 pounds to approximately 160 pounds per cubic-foot, (b) that the majority of said supported-firebricks of said course are light-weight insulation-firebricks having a density of not to exceed 70 pounds per cubic-foot, (c) that said refractory-firebricks are supported on said sustaining-bars by the outer end parts only of said firebricks, (d) that said courses of supported-firebricks are supported solely by the parts of said rows of refractory-firebricks extended inwardly of the furnace beyond their sustaining and retaining bars, and (e) that each said set of courses of said supported-firebricks extend upwardly from its supporting row of refractory-firebricks to the next upper row of such refractory-firebricks.

11. The novel combination of features set forth in claim 10 in which all of the supported-firebricks are of the specified light-weight insulation type, in which each row of said supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of light-weight insulation-firebricks supported immediately above and below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row, and in which the bricks of said above and below rows have a dimension corresponding to the thickness of the wall less than that of the other courses of supported-firebricks.

12. In a sectional furnace-wall having upright columns, horizontal metal sustaining-bars mounted in vertically-spaced relation on said columns, horizontal metal retaining-bars mounted in vertically-spaced relation on said columns, each such retaining-bar being complementary to and located above one of said sustaining-bars and having a depending portion, said columns and bars defining the sections of the wall, vertically-spaced rows of supporting-firebricks each row bearing on and supported by one of said sustaining-bars and maintained in place thereon by engagement with said portion of the companion retaining-bar, and superimposed courses of supported-firebricks between successive rows of said supporting-firebricks, the novel combination of features being (a) that said supporting-firebricks are refractory-firebricks having a heat-conductivity of from approximately 7 to approximately 9 B. t. u. per square-foot per inch thickness per degree Fahrenheit difference in temperature at a mean temperature of 1000 degrees Fahrenheit, (b) that the majority of said supported-firebricks of said courses are of light-weight insulation-firebricks having a heat conductivity under the same conditions of about $1\frac{1}{2}$ to about $3\frac{1}{2}$ B. t. u. per square-foot per inch thickness per degree Fahrenheit difference in

temperature, (c) that said refractory-firebricks are supported on said sustaining-bars by the outer end portions only of said firebricks, (d) that said courses of supported-firebricks are supported solely by the portions of said rows of refractory-firebricks extended inwardly of the furnace beyond their sustaining and retaining bars, and (e) that each said set of courses of said supported-firebricks extend upwardly from its supporting row of refractory-firebricks to the next upper row of such refractory-firebricks.

13. The novel combination of features in furnace-walls set forth in claim 12 in which all of the supported-firebricks are of the specified light-weight insulation type, in which each row of said supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of light-weight insulation-firebricks immediately above and below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row, and in which the bricks of said above and below rows have a dimension corresponding to the thickness of the wall less than that of the other courses of supported-firebricks.

14. In a sectional furnace-wall having upright columns, horizontal metal sustaining-bars mounted in vertically-spaced relation on said columns, horizontal metal retaining-bars mounted in vertically-spaced relation on said columns, each such retaining-bar being complementary to and located above one of said sustaining-bars and having a depending portion, said columns and bars defining the sections of the wall, vertically-spaced rows of supporting-firebricks, each row bearing on and supported by one of said sustaining-bars and maintained in place thereon by engagement with said portions of the companion retaining-bar, and superimposed courses of supported-firebricks between successive rows of said supporting-firebricks, the novel combination of features being (a) that said supporting-firebricks are refractory-firebricks having a modulus of rupture of approximately 800 pounds to approximately 900 pounds per square-inch, (b) that said supported-firebricks have a heat con-

ductivity of about $1\frac{1}{2}$ to about $3\frac{1}{2}$ B. t. u. per square-foot per inch thickness per degree Fahrenheit difference in temperature at a mean temperature of 1000 degrees Fahrenheit, (c) that said refractory-firebricks are supported on said sustaining-bars only by the outer end portions of said firebricks, (d) that said courses of supported-firebricks are upheld solely by the parts of said rows of refractory-firebricks extended inwardly of the furnace beyond their sustaining and retaining bars, and (e) that each said set of courses of said supported-firebricks extend upwardly from its supporting row of refractory-firebricks to the next upper row of such refractory-firebricks.

15. The novel combination of features in furnace-walls set forth in claim 14 in which each said row of supporting refractory-firebricks has tongue-and-groove interlocking connections with the rows of supported-bricks immediately above and below such row of supporting-firebricks, the bricks of such two rows above and below such intermediate row being alike except that the bricks of one such row are inverted with relation to those of the other row, and in which the bricks of said above and below rows have a dimension corresponding to the thickness of the wall less than that of the other courses of supported-firebricks.

16. The furnace-wall set forth in claim 3 in which at least some of said sustaining-bars each comprises a pair of angle-bars secured together with the outer faces of two of their flanges in contact with one another and with their remaining two flanges projecting in opposite directions in the same plane, said latter pair of flanges being fastened to the columns.

17. The furnace-wall set forth in claim 3 in which at least some of said retaining-bars each comprises a pair of angle-bars secured together with the outer faces of two of their flanges in contact with one another and with their remaining flanges extending in opposite directions at the opposite sides of the duplex-bar, the one of such latter flanges being fastened to the columns, the other flange retaining the corresponding row of supporting refractory-firebricks in place.

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