

[54] **PREFABRICATED AND PRESTRESSED
MODULAR FURNACE UNITS**

[72] Inventor: Stephen Lewicki, Orchard Lane, Wallingford, Pa. 19086

[22] Filed: Aug. 21, 1970

[21] Appl. No.: 65,817

[52] U.S. Cl. 110/1 A, 110/99 R

[51] Int. Cl. F23m 5/00

[58] Field of Search 110/1, 1 A, 99, 99 B; 52/248; 122/494, 510

[56] **References Cited**

UNITED STATES PATENTS

1,601,485	9/1926	Abbott.....	110/99
3,456,835	7/1969	Marcmann.....	52/248 X

FOREIGN PATENTS OR APPLICATIONS

512,013	6/1952	Belgium.....	110/1 A
---------	--------	--------------	---------

Primary Examiner—Kenneth W. Sprague

Attorney—Samuel Lebowitz

[57]

ABSTRACT

A prefabricated modular furnace unit built up of a plurality of longitudinally extending refractory brick elements to form a substantially closed perimetric figure in cross section. The bricks have juxtaposed mitered edges free of any mortar between them to permit them to move relatively to each other in radial directions in response to temperature variations. A spring-loaded sheath of high tensile strength on the exterior of the bricks maintains the unit in integrated compressed condition at all times while permitting expansion in response to thermal variations. The cross sections of the modular units may vary and the units of the same cross section may be combined to any length. The modular units may be closed at the ends thereof with either fixed or movable end closures of sheathed firebrick assemblies. Also, their thermal efficiency may be increased by providing bodies of insulating material between the bricks and sheaths. The modular units lend themselves to continuous car-type muffle furnaces, or ovens, by providing a gap in the perimeter of the firebricks, which are compressed at their juxtaposed edges by suitable spring-loaded sheathing to permit the travel of the furnace conveyor components at said gap relative to the main fixed portion of the furnace housing.

17 Claims, 6 Drawing Figures

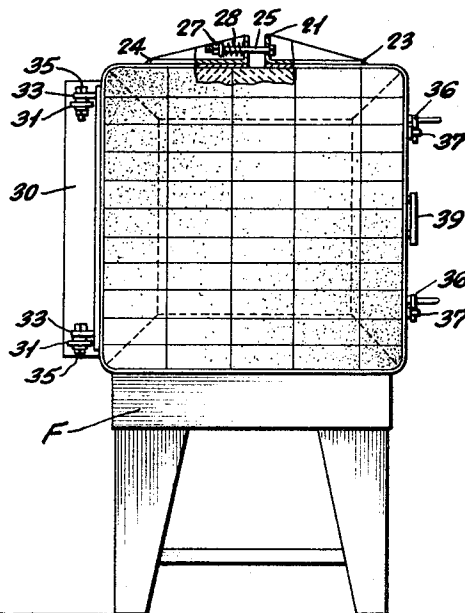
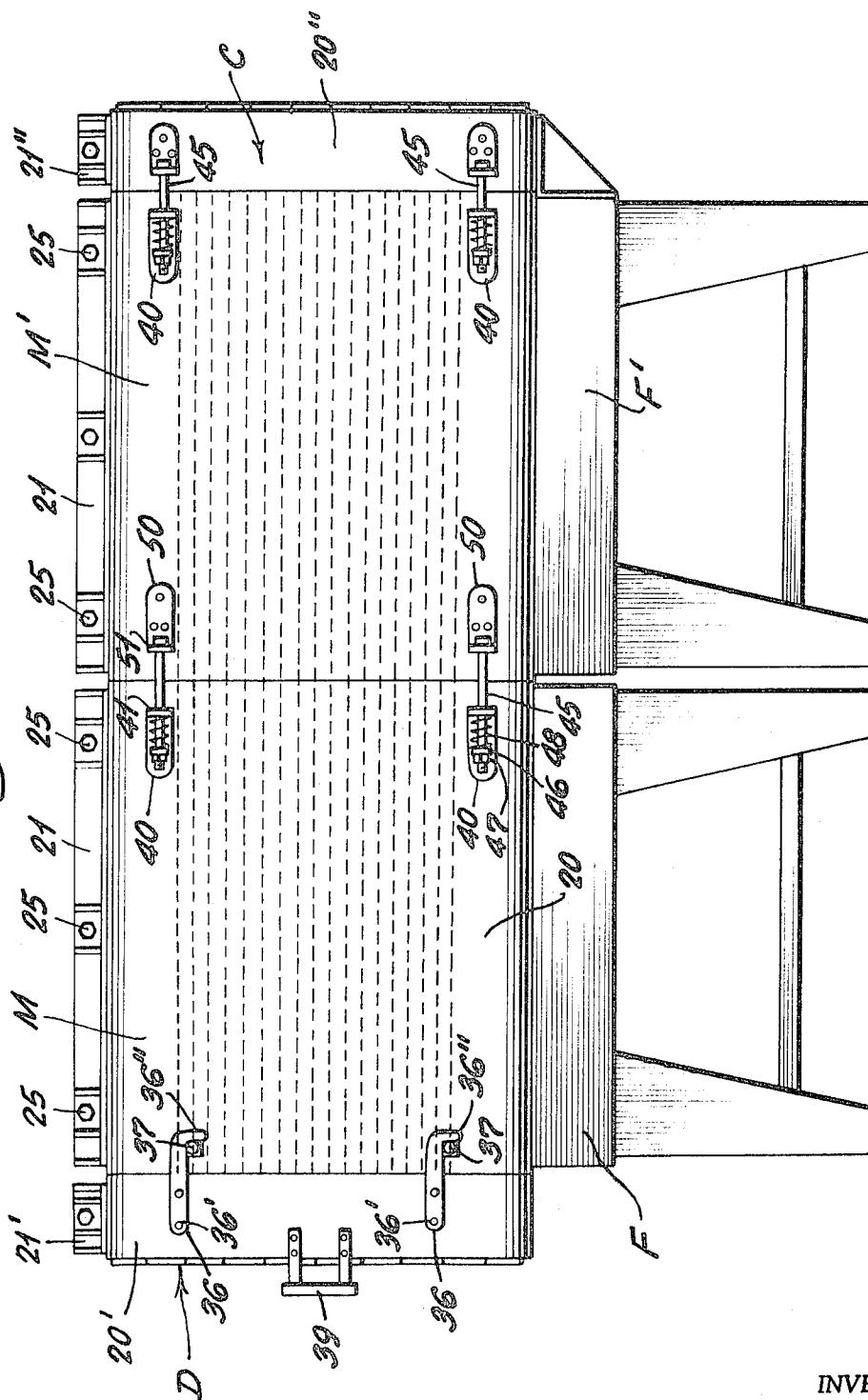


Fig. 1.



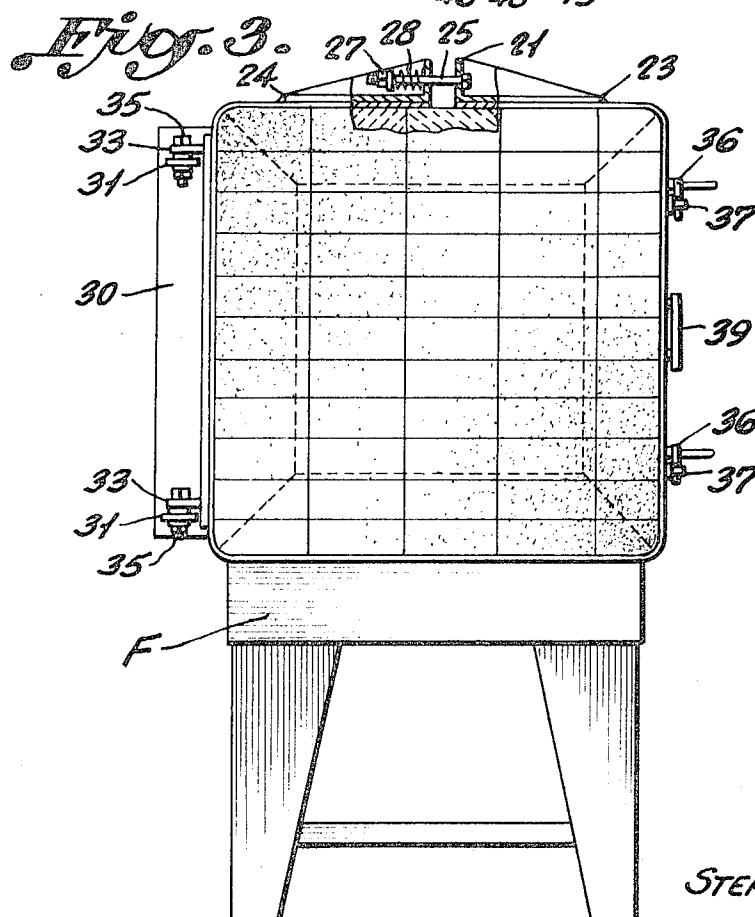
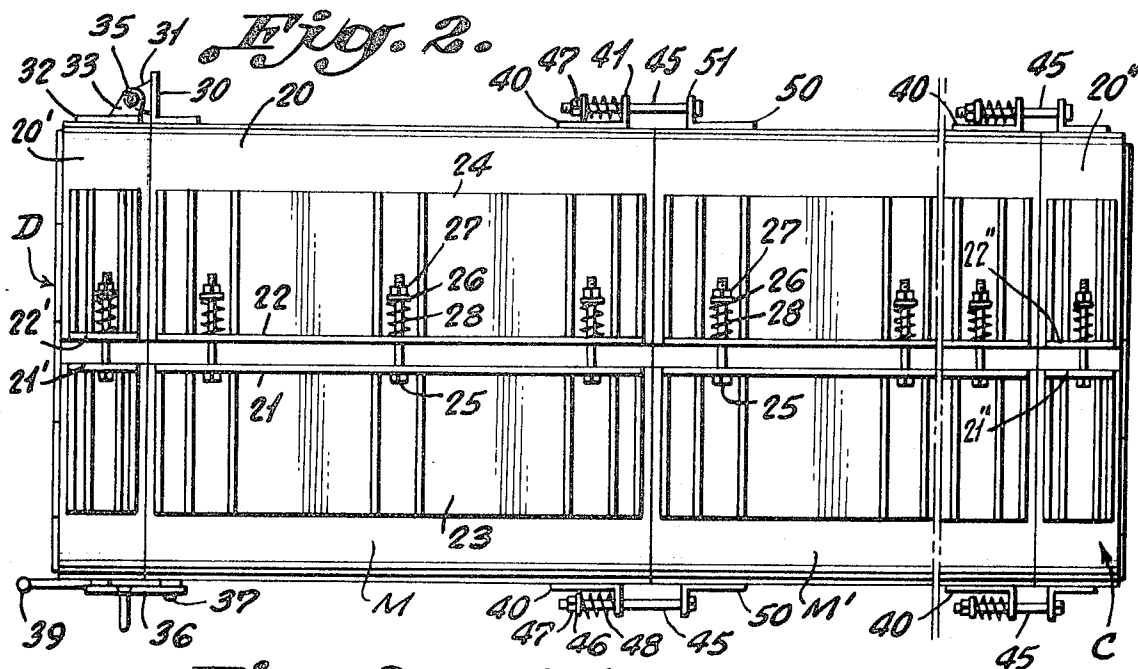
INVENTOR

STEPHEN LEWICKI

BY

Samuel Blount

ATTORNEY

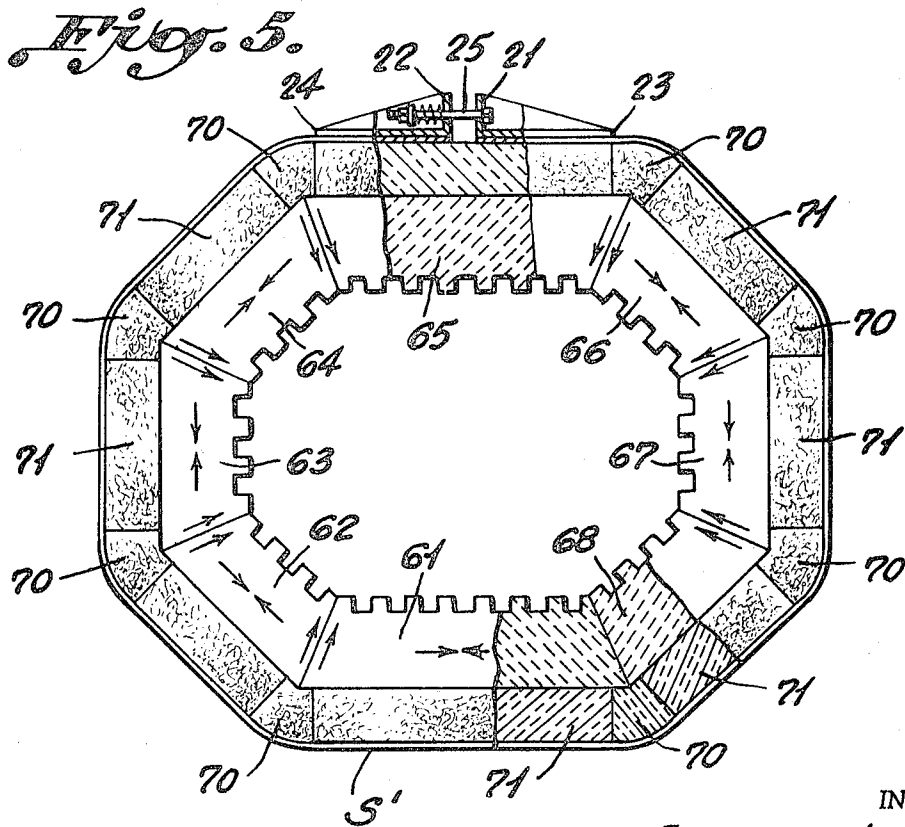
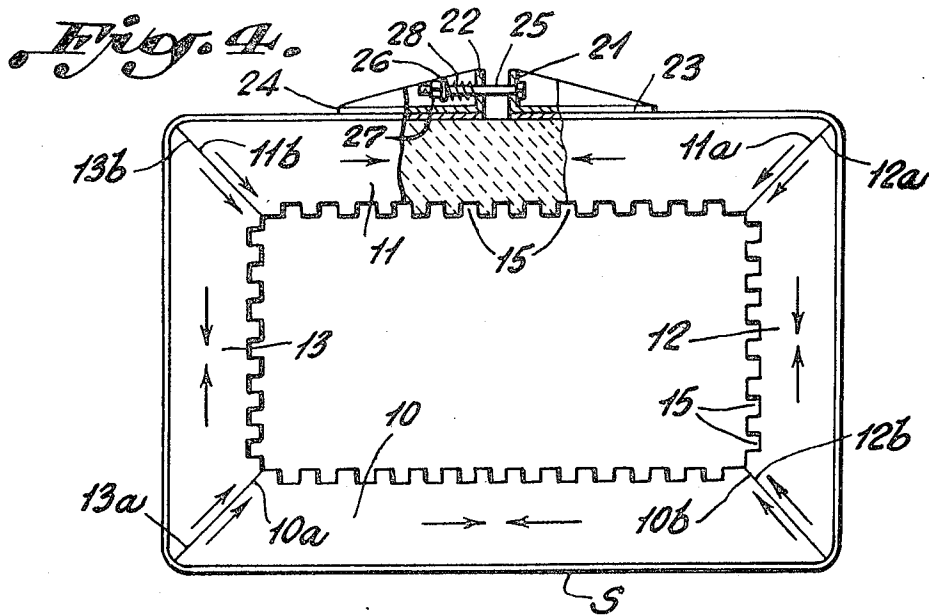


INVENTOR

STEPHEN LEWICKI

BY

Salvatore Feloni
ATTORNEY



INVENTOR

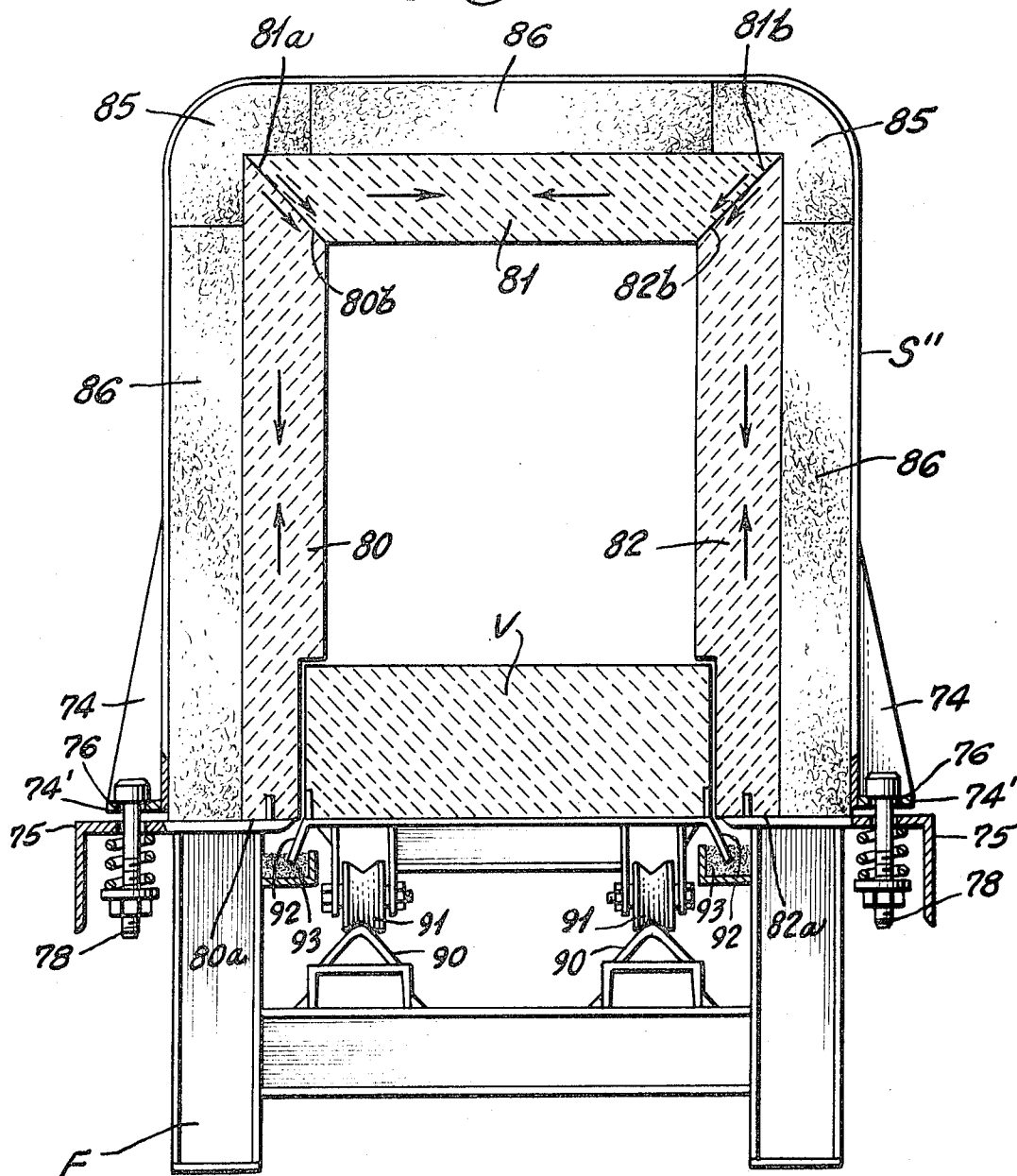
STEPHEN LEWICKI

BY

Samuel Blount

ATTORNEY

Fig. 6.



INVENTOR

STEPHEN LEWICKI

BY

Samuel Blount
ATTORNEY

PREFABRICATED AND PRESTRESSED MODULAR FURNACE UNITS

This invention relates to a modular furnace construction and more particularly to a prefabricated structural system for producing insulated chambers suitable for ovens, furnaces and similar enclosures.

It is the object of the present invention to provide prefabricated chamber constructions which are adapted for heating by hot gases or electricity, and which may be fabricated of many different contours and sizes in dependence upon particular needs. The modular construction of the units renders it highly adaptable to many different layouts and floor plans.

It is another object of the present invention to provide a modular furnace construction which is free of any masonry at the mating edge joints and yet is highly economical in its utilization of heat energy by virtue of its leak-proof characteristics in consequence of the prestressed assembly of the components constituting the modular units.

It is another object of the invention to provide a modular furnace construction which is not only rugged and reliable in design, economical in construction, but also easy and economical to maintain by virtue of the knockdown characteristics of the chamber assembly which permits an easy replacement of individual bricks, or a convenient servicing of an entire furnace module by substituting a replacement therefor.

The invention proceeds upon the principle of assembling a plurality of refractory firebrick elements with edges in juxtaposed relation and arranging them to form a substantially closed perimetric figure, and yieldingly retaining these brick elements in their juxtaposed position by spring means of predetermined force to provide a tightly sealed furnace chamber. Nevertheless, the yieldable binding of the brick elements at predetermined compressive forces permits a radial movement of the bricks along the mating edges thereof in response to temperature variations to maintain the sealed condition of the furnace intact, despite the stresses imposed upon the individual brick elements. These movements are possible without spalling or fracture of the bricks by virtue of the flexible sheathing surrounding the modular assembly which permits free relative movement of the bricks while maintaining the integrity of the joint between adjacent brick elements.

The modular units in accordance with the invention lend themselves to variations in design by providing an assembly of rigid firebricks encompassed by a yieldable sheath of high tensile strength, or one which includes an intermediate layer of additional insulating material, to enhance the thermal efficiency of the furnace units. In every instance the furnace chamber is surrounded by a jacket or sheath which tightly surrounds the exterior surface of the assembly with a yielding force, which is generally provided by spring means of predetermined loadings. The modules lend themselves to expansion of the furnace capacity and conversion to different designs. Not only does the modular construction lend itself to fixed chambers which may be mounted on supporting frames, but may be adapted to a furnace construction for accommodating travelling units which may be moved safely and conveniently into and out of the furnace.

The furnace is adapted to embody end closures, whether in the form of fixed end walls or movable doors, the fire bricks of which are integrated yieldingly in the same manner as the modular units, so that the readily expansible and contractile components of the assembly are present at all points of the furnace construction.

Other objects and purposes will appear from the detailed description of the invention following hereinafter, taken in conjunction with the accompanying drawings, wherein

FIG. 1 is a front elevation of a modular furnace construction in accordance with the invention;

FIG. 2 is a plan view of the furnace shown in FIG. 1;

FIG. 3 is a left end view of FIG. 2;

FIG. 4 is a sectional view of a variant embodiment of a modular furnace unit in accordance with the invention;

FIG. 5 is a sectional view illustrating a different embodiment of the modular unit, being of octagonal cross section; and

FIG. 6 is a vertical sectional view, with certain parts in elevation, illustrating a modular unit adapted to continuous conveyor or cartype furnace installations.

As shown in the drawings, the modular units M, M' in accordance with the invention may be mounted upon supporting frames F, F' and such units may be used singly or may be coupled together in any desired lengths, as shown in the drawings. In the double unit shown in FIG. 1, a door D is provided at the front of the furnace and an end wall C is provided at the rear thereof.

While FIG. 3 shows a modular furnace unit of square cross-section, this outline can be varied to suit any need, and FIGS. 4 and 5 show variations of the cross section of the furnace unit which may be fabricated in any desired size, for example, that ranging from a furnace adapted for laboratory use to one for larger industrial use.

The assembly of the fire bricks shown in FIG. 4 on a larger scale, illustrates the base brick 10 with 45° mitered edges 10a and 10b in close juxtaposed relation with the lower edges 13a and 12b of the vertical bricks 13 and 12, respectively. The upper fire brick 11, with its opposite mitered 45° edges 11a and 11b, are in close juxtaposition with the upper edges 12a and 13b of the vertical bricks 12 and 13, respectively. The bricks are free to move relatively to each other along juxtaposed mitered edges, and are maintained in a prestressed condition by a sheath S of metal or other high tensile strength fire-resistant material, which surrounds the entire outer perimeter of the bricks. The individual bricks 10-13 may be of integral construction or may be built of multiple blocks joined together in known manner.

As shown in FIG. 4, one free edge of the sheath S terminates in a bracket 23 rigidly affixed thereto which terminates in an upstanding wall 21. A bracket 24 with an upstanding wall 22 is rigidly affixed to the opposite edge of the sheath. Aligned openings are provided at longitudinally displaced points of the bracket walls 21 and 22 for the passage of bolts 25 therethrough. The head end of each bolt 25 abuts against the wall 21 while the opposite end is fitted with a spring 28, washer 26, and a nut 27 so that the walls 21 and 22 are adapted to be drawn together into relatively close juxtaposition to force the fire bricks 10 to 13 into tight engagement to prevent leakage of heat from the furnace. However, the absence of any masonry at the joint between the bricks permits the outward movement thereof against the force of the springs 28, without affecting the sealing joints at the juxtaposed edges of the bricks. By suitably designing the strength of the springs, the yieldability of the fire bricks may be controlled, in dependence upon the temperature gradients which are encountered.

As shown in FIG. 2, the modular units may be coupled together in end-to-end relationship by the provision of L-shaped brackets 40 on one end of the modular unit M, and L-shaped brackets 50 on the adjacent end of the other unit. The vertical plates 41 of the brackets 40 and the vertical plates 51 of the brackets 50 are provided with openings for the passage of bolts 45 therethrough, which are spring-loaded with spiral springs 48 at a variable compression by means of nuts 47 acting on washers 46 between the nuts and the springs.

Any number of these units may be arranged in end-to-end relation to obtain any desired length of furnace.

A door closure D is adapted to be mounted on the front end of the furnace by the provision of angle brackets 30 (FIGS. 2 and 3), at one end of the wall 20 of the sheath S. This wall 20 may have lugs 31 which cooperate with lugs 33 projecting from the bracket 32 mounted on the sheath 20' of the door D. Bolt hinges 35 pass through openings in the lugs 31 and 33 to permit a hinging movement of the door for the purpose of attaining access to the furnace. The opposite edge of the door is provided with latch members 36 which are pivotally mounted at 36' and which are provided with hooks 36'' for selective engagement with rods 37 projecting laterally from the sheath 20.

A handle 39 at the end of the door facilitates manipulation of the door in its to-and-fro movements.

The opposite end of the furnace unit may be sealed by a closure C consisting of an assembly of juxtaposed bricks arranged in a form having a perimeter corresponding to that of the modular units M and M', and which are maintained in closely integrated condition by a sheath 20'' of metal or other strong heat-resistant material, the ends of which are fitted with bracket projections 21'' and 22''. The latter are coupled together by spring-loaded bolts in the same manner as described above in connection with the main sheaths surrounding the modular units M and M'.

In both the door closure D and end closure C it is necessary that only the perimetric bricks be free of any masonry joints; those at the interior may be joined to each other in any desired way.

As shown in FIG. 4, the interior of the furnace is provided with channels 15 to accommodate heating coils for energization by a source of electricity in a manner disclosed in greater detail in my U.S. Pat. No. 2,744,946, May 8, 1956. However, the bricks may be of any other contour, and may be plane, if the furnace unit is designed to be heated by hot gases generated by liquid or gaseous fluids.

The cross-sectional contour of the furnace may assume many other different forms than square or rectangular, as shown in FIGS. 3 and 4. For example, the contours may be circular, ellipsoidal or polygonal. In FIG. 5 is shown a furnace module of octagonal cross section, which is composed of eight fire bricks 61 and 68 with the edges mitered in juxtaposed relation to permit relative radial movement between the fire bricks as their temperatures vary. These rigid fire bricks are additionally surrounded with a mass of heat insulation to increase the heating efficiency of the furnace. As shown in FIG. 5, spacers 70 of rigid material superpose each of the junctions between the fire bricks, with their inner faces conforming to the contours of the bricks while their outer faces are rounded in order to accommodate smoothly the sheath S' which surrounds the furnace module and which is provided at the free ends thereof with coupling brackets 23 and 24 having upstanding walls or flanges 21 and 22, through which extend the yielding fastening bolts, similar to those disclosed in connection with the modular unit shown in FIG. 4. The spacer 70 may be of ceramic or other material capable of withstanding the compressive forces which are adapted to be transmitted between the fire bricks and the sheath. The spaces between the spacers 70 may be filled with masses 71 of insulating material of lesser mechanical strength, for example, fibrous material such as fiberglass, rock wool, pelletized insulating material, and the like.

Of course, the end closures for the modular units of the type shown in FIG. 5, that is, elements D and C, conform in outline to that shown in FIG. 5.

In FIG. 6 is shown a furnace casing which may be built up of a plurality of modules to attain a travelling conveyor or car muffle furnace or the like. In such an assembly the frame F supports the spaced vertical fire bricks 80 and 82 of the furnace, the lower edges 80a and 82a of which rest upon the angle frame 75 of the frame, while the upper mitered edges 80b and 82b cooperate with the correspondingly mitered edges 81a and 81b of the upper fire brick 81.

The metallic sheath S'' is provided with brackets 74 at the opposite ends thereof with openings 76 in the horizontal projections 74' adapted to accommodate spring-loaded bolts 78 in a manner similar to that described above. Rigid spacers 85, with rectangular corners on the interior and rounded surfaces on the exterior, are provided at the opposite edges of the casing, to permit the firebricks to be forced into tight engagement by the tightening of the bolts 78 while permitting the expansive movement of the sheath in response to the movement of the firebricks as these are transmitted through the rigid spacers 85. The spaces within the sheath S'' bounded by firebricks and rigid spacers may be filled with loose insulating material 86 of fibrous or pelletized form.

The fixed part of the furnace module operates in the same manner as described above when the firebricks move in response to temperature variations.

The frame F may be provided with longitudinally extending rails 90 on which a travelling vehicle or conveyor, comprised of any desired firebrick pallets or receptacles, may move through the intermediary of rollers 91. Flanges 92 extend from the floor of the vehicle or conveyor into beds 93 of sand or other sealing material affixed to the frame, along which they may travel to prevent leakage of heat from the interior of the furnace.

The function of prestressing the firebricks by spring-loaded bolt assemblies acting between brackets affixed to the ends of the sheath may be subdivided among two or more of such assemblies. Thus, in the arrangements shown in FIGS. 1 to 4, bracket and spring assemblies may be provided on the sides as well as on the top of the modular furnace. The shorter lengths of sheathing would render the springs more sensitive to the changes in the dimensions of the furnace modules.

The flexible sheaths of sheet metal or other material of high tensile strength which are maintained in encompassing relation on the exterior of the firebricks by means of spring-loaded bolts illustrate only one way of attaining a yieldable casing around the firebricks. The same objectives may be realized in other ways. Thus, a pre-stressed plate of spring steel of cylindrical contour with the edges thereof in adjacent overlapping relation may be opened by force to accommodate the exterior periphery of the firebricks. Upon the release of the force, the cylindrical spring sheath contracts to bind the bricks therein. Such a yielding casing could be used most effectively with modules of circular or elliptical cross section. If desired, such spring plates may be combined with surrounding sheaths which are forced into encompassing relation on the exterior of the module by spring-loaded bolts, as shown and described above.

The advantages of the present invention may be attained to a lesser degree even when the furnace modules are formed of interfitting bricks to define the perimetric boundaries of the modules which are surrounded by yieldable sheaths which expand and contract in response to variations in temperature of the modules.

I claim:

1. The method of integrating a plurality of refractory bricks, in juxtaposed relation to form a furnace enclosure, which comprises

- a. arranging the bricks in perimetric form with the edges of adjacent bricks in juxtaposed mating relation with each other along angularly mitered planes and free of any binding medium therebetween, and
 - b. yieldingly encompassing the periphery of the bricks on the exterior of the furnace enclosure with a resilient member to permit freedom of radial movement of said bricks along said edges in a plurality of directions in response to temperature variations in said enclosure without affecting the integrity of the joints at said edges.
2. A furnace or oven module, comprising
- a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,
 - b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements presenting juxtaposed mating surfaces of extended areas, and free of any integrating medium therebetween,
 - c. said brick elements being prestressed in abutting relation with each other to form tight joints therebetween extending over surfaces of substantial area around the complete perimetric figure,
 - d. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement, and

- e. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations.
- 3. A module as set forth in claim 2, wherein the juxtaposed mating surfaces of the adjacent brick elements are disposed along angular mitered planes to form perimetric figures of variable cross section.
- 4. A furnace or oven module, comprising
 - a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,
 - b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements, and free of any integrating medium therebetween,
 - c. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
 - d. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations,
 - e. end closures for said module, each composed of a plurality of internal refractory brick elements surrounded by additional refractory brick elements free of any integrating medium therebetween, and having an external boundary conforming to said perimetric figure, and
 - f. a yieldable sheet surrounding said external boundary, to permit expansive and contractile movements of said end closures in response to temperature variations.
- 5. An apparatus as set forth in claim 4, wherein at least one of said end closures is pivotally mounted on said yieldable member to provide convenient access to the interior of said module.
- 6. An apparatus as set forth in claim 4, including means for connecting yieldingly one of said end closures to one end of said module, comprising a plurality of pairs of coupling brackets on said one end closure and the end of the module adjacent thereto, and a bolt and nut assembly with a surrounding coiled spring extending between each pair of said coupling brackets.
- 7. A furnace or oven module, comprising
 - a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,
 - b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements, and free of any integrating medium therebetween,
 - c. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
 - d. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations,
 - e. said last-mentioned spring means comprising a coupling bracket rigidly affixed to each end of said yieldable sheet metal member having a longitudinal outwardly extending flange provided with openings at spaced points therealong in alignment with corresponding openings in the coupling bracket affixed to the other end of said yieldable member, and a bolt and nut assembly with a surrounding coiled spring extending through each pair of aligned openings in said coupling brackets to adjust the compressive force exerted by said yieldable member on the exterior of said brick elements.
- 8. A furnace or oven module, comprising
 - a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,

- b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements, and free of any integrating medium therebetween,
- c. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
- d. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations, and
- e. rigid spacers between the exterior of said brick elements and said yieldable sheet metal member overlying the adjoining edges of said brick elements, said spacers having sharp corners on the inner faces thereof conforming to the angularity of the external faces of said brick elements and curved surfaces on the exterior thereof in contact with said yieldable sheet metal member to facilitate relative movement therebetween.
- 9. An apparatus as set forth in claim 8, including insulating material of low compressive characteristics in the spaces defined between said rigid spacers and between the brick elements and yieldable sheet metal member.
- 10. A furnace or oven construction composed of a plurality of modules as set forth in claim 2, including means for connecting said plurality of modules in end-to-end relation.
- 11. An apparatus as set forth in claim 10, wherein said last-mentioned means is yieldable.
- 12. A furnace composed of a plurality of furnace or oven modules each comprising
 - a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,
 - b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements, and free of any integrating medium therebetween,
 - c. a yieldable member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
 - d. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations, and
 - e. yieldable means for connecting said plurality of modules in end-to-end relation comprising a plurality of pairs of coupling brackets on adjacent ends of said modules, and a bolt and nut assembly with a surrounding coiled spring extending between each pair of said coupling brackets.
- 13. A furnace housing formed of a plurality of furnace modules connected to each other in end-to-end relation,
 - a. each module comprising a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section with a gap at the lower end thereof,
 - b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements, and free of any integrating medium therebetween,
 - c. a frame for supporting the opposite edges of said furnace housing outwardly of said gap at the lower end thereof,
 - d. a yieldable sheet metal casing surrounding said perimetric figure on the top and sides thereof and provided with ends terminating slightly above said supporting frame,
 - e. spring means acting on said ends to maintain the casing in tight envelopment relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations,
 - f. a support movable on said frame in said gap of said perimetric figure, and
 - g. sealing means between said frame and the bottom of said movable support to prevent the leakage of heat thereat in the course of movement of said support relative to said furnace housing.

14. An apparatus as set forth in claim 13, wherein said frame is provided with longitudinally extending rails below said gap, and rollers on the bottom of said support adapted to engage said rails.

15. A furnace module comprising

- a. a plurality of refractory brick elements extending longitudinally in juxtaposed relation and forming a substantially closed perimetric figure in cross section,
- b. each of said brick elements having edges conforming in contour to the edges of the adjacent brick elements presenting juxtaposed mating surfaces of extended areas,
- c. said brick elements being prestressed in abutting relation with each other to form tight joints therebetween extending over surfaces of substantial area around the complete perimetric figure, and
- d. a yieldable sheet-metal member surround at least the major portion of said perimetric figure and including spring means for exerting tension on the exterior of said brick elements to maintain them in prestressed position with the capability of relative movement therebetween in response to temperature variations while maintaining the integrity of the closed perimetric figure.

16. A furnace module, comprising

- a. a plurality of refractory brick elements in juxtaposed relation and free of any integrating medium therebetween to form a substantially closed perimetric figure in cross section,
- b. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
- c. a coupling bracket rigidly affixed to each end of said yieldable sheet metal member adjacent to said coupling edges and comprising a longitudinal outwardly extending

flange provided with openings at spaced points therealong in alignment with corresponding openings in the coupling bracket affixed to the other end of said yieldable member, and

- d. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations, said spring means comprising a bolt and nut assembly with a surrounding coiled spring extending through each pair of aligned openings in said coupling brackets to adjust the compressive force exerted by said yieldable member on the exterior of said brick elements.

17. A furnace or oven construction composed of a plurality of furnace modules each comprising

- a. a plurality of refractory brick elements in juxtaposed relation and free of any integrating medium therebetween to form a substantially closed perimetric figure in cross section,
- b. a yieldable sheet metal member surrounding said perimetric figure comprising flexible sheet portions surrounding the major periphery of said perimetric figure and including coupling edges adapted for relative movement,
- c. spring means acting on said edges to maintain the casing in tight enveloping relation around said brick elements despite the expansive and contractile movements of said elements in response to temperature variations,
- d. yieldable means for connecting said plurality of modules in end-to-end relation comprising a plurality of pairs of coupling brackets on adjacent ends of said modules, modules in end-to-end a bolt and nut assembly with a surrounding coiled spring extending between each pair of said coupling brackets.

* * * * *

40

45

50

55

60

65

70

75

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,665,870 Dated May 30, 1972

Inventor(s) STEPHEN LEWICKI

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

In claim 15, column 7, line 16, "surround" should be --surrounding--.

In claim 17, column 8, line 32, "modules in end-to-end" should be cancelled, and the word --and-- should be substituted therefor.

Signed and sealed this 29th day of August 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents