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R. SNELLMAN

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SHAPES AND METHOD FOR LINING A ROTARY KILN

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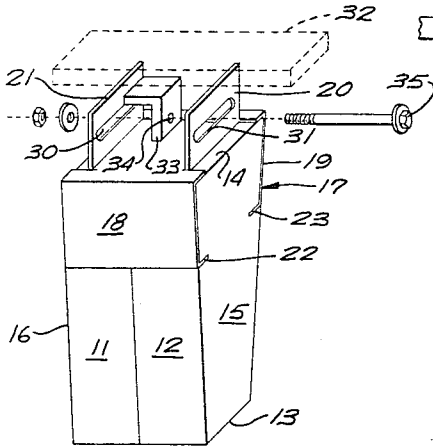


Fig. 1

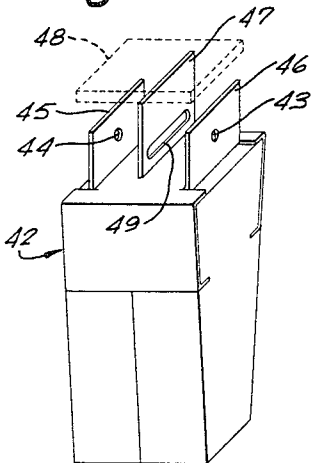


Fig. 3

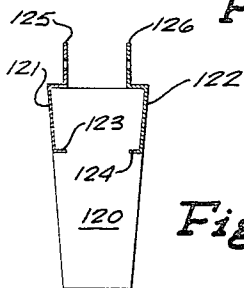


Fig. 8

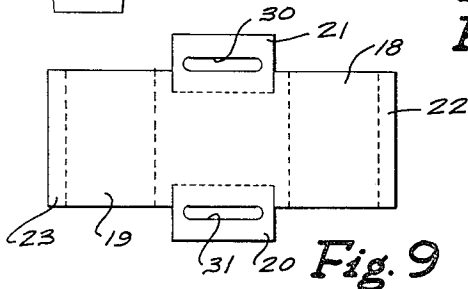


Fig. 9

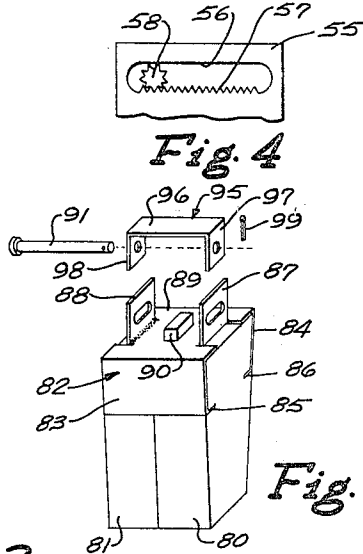


Fig. 4

Fig. 6

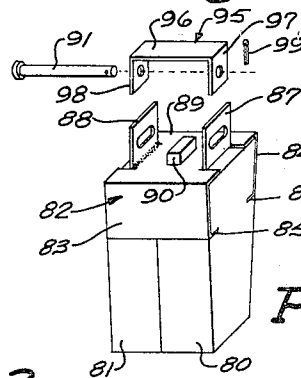
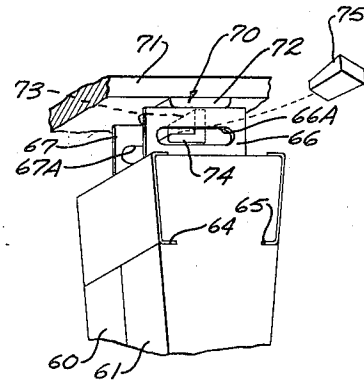


Fig. 5

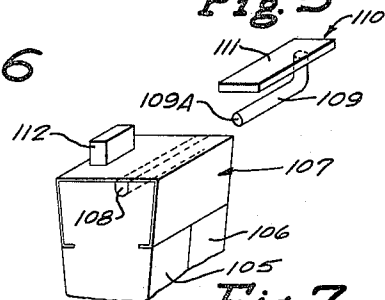
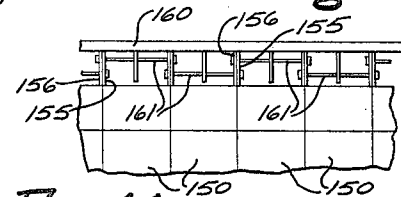


Fig. 7



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SHAPES AND METHOD FOR LINING A ROTARY KILN

Roger Snellman, Birmingham, Mich., assignor to Harbison-Walker Refractories Company, Pittsburgh, Pa., a corporation of Pennsylvania

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ABSTRACT OF THE DISCLOSURE

The combination of a lining and a vessel characterized by a generally circular or arcuate cross-section along a substantial portion of a horizontal or nearly horizontal longitudinal extent, the lining being comprised of two types of brick a first type of which is arranged to wedge in position a second type of brick to form said lining, the second type of brick being conventional in shape.

In laying up refractory linings in vessels of the foregoing type, it has been conventional to use rather extensive temporary wooden scaffolding, support forms, and the like, temporarily to hold sequentially in position sections of arcuate courses of the lining during subsequent rotation of the vessels to complete a given said arcuate course or courses. For example, a portion of a circular ring or course of brick is laid up through the bottom 180° of the internal circumferential surface of a rotary kiln, support forms are put in place of firmly anchor the brick in place, and then the vessel is rotated to place the positioned 180° of brick at the top and place the remaining bare shell at the bottom. The lower 180° of the given course is subsequently laid to contiguously about the previously laid, now top, 180° of the ring to thereby complete the ring. The completed ring is self-sustaining, and the forms may be removed.

As is well known by those skilled in this art, the expense and time required for the installation and removal of this extensive, and yet previously thought necessary, scaffolding is distasteful. In many instances, it is necessary to have two crews of skilled workers for the installation of such a lining using these prior techniques: first, bricklayers and/or masons, and, secondly, skilled carpenters.

It is a primary object of this invention to provide a shape which can be used in building refractory linings for vessels characterized by a generally circular or arcuate cross section along a substantial portion of a horizontal or nearly horizontal axis, without the necessity of extensive temporary scaffolding and related temporary support structure.

It is a further object of this invention to provide a novel combination of a composite shape and support structure, which support structure is arranged to be permanently affixed in a shell of a vessel of the foregoing type, which shape and support structure cooperate to provide for a refractory lining which can be constructed without the use of temporary scaffolding, support structure, or the like.

Briefly, according to one embodiment of this invention, there is provided a partially metal-encased refractory key type shape. The large end of the key, which is the cold end (that furthest away from the high temperature zone of the vessels when they are in operation), is associated with the metal casing. The metal casing, in one embodiment, includes two pair of oppositely directed arms, which pairs are interconnected to each other, but at right angles to each other. A first of the pair of arms extends downwardly over the opposed tapering flat side faces of the key and have their lower edges extending in-

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wardly of the brick body to hold the brick and case together. The outer face of these arms either falls in the same plane as the remaining uncovered portion of the flat faces or in a plane beneath it, so brick in an adjacent course can be abutted contiguously to each other. The other two arms, which extend upwardly from the cold face, have opposed aligned apertures formed through them. These apertures are arranged to cooperate with an aperture in a lug extending inwardly from the shell. The lug is permanently affixed as by welding to the shell. The apertures through the arms extending from the cold face, and that in the lug, are arranged to receive a pin or the like to thereby affix the key to the lug and, thus, the shape to the vessel shell. The support structure is so constructed and arranged as to hold the key firmly in place against the shell.

To form a ring or course in such as a rotary kiln, one of these special shapes, in one embodiment, is affixed each 90° about the circular cross section and in a common ring of the lining to be built. Thus, in laying up the lining, one affixes one or more horizontally aligned key shapes of this invention to one or more lowermost lugs. Regular and conventional key or wedge shapes are run up from either side of these first special shapes through about 90° on each side. Additional of the special shapes are then attached to their lugs in such a position as to firmly abut against the last brick of the 90° portions of the course or courses which have been previously laid. The resulting 180° of the courses is self-sustaining. The vessel can then be rotated, and the remainder of the courses finished.

The foregoing system is repeated the length of the generally horizontal portion of the kiln. The foregoing arrangement thereby eliminates all temporary forms, scaffolding, and the like.

A better understanding and other features and advantages of this invention will be readily understood by those skilled in the refractories, metallurgical, and related arts, by a study of the following detailed description of the exemplary drawings. In these drawings:

FIG. 1 is a perspective view of the novel shape and support structure combination of this invention;

FIG. 2 is a view of one side of the arrangement of FIG. 1;

FIG. 2A is a view of another side of the arrangement of FIGS. 1 and 2;

FIG. 3 is an alternative construction for a shape according to this invention;

FIG. 4 is an alternative construction for the upwardly extending arms of the shape of FIG. 1;

FIG. 5 is another alternative shape and support structure utilizing the concepts of this invention;

FIG. 6 is still another alternative construction;

FIG. 7 is an additional alternative construction, in which the upwardly extending arms are eliminated and the brick itself is modified to cooperate with modified support structure;

FIG. 8 is a side sectional view of another alternative construction according to this invention;

FIG. 9 is a sheet metal blank from which the metal casing of the construction of FIG. 1 can be made.

FIG. 10 is still another alternative construction according to this invention; and

FIG. 11 is a schematic diagram indicative of the manner in which the shapes of FIG. 10 are used.

Before describing the drawings in detail, it should be understood they are but exemplary of constructions utilizing the inventive concepts herein disclosed, and modifications may be had therein to arrive at still other constructions within the spirit and scope of my invention. It should be further understood that and true measure of the

spirit and scope of this invention is as defined in the hereafter appended claims.

For a better understanding of the present invention it is thought definition of some terminology used hereafter would be useful. In a preferred embodiment, I speak of a pair of "key" shapes, which are bound together in a unitary metal casing arrangement to provide a larger, composite key-like shape. Among many other conventional shapes manufactured and sold in the refractories industry are those called "arch," and "wedge" shapes. These shapes are characterized by a pair of opposed sloping sides. Depending on which sides taper, the shape falls into one of the categories just noted. Further background may be had by reference to the book "Modern Refractory Practice," 4th edition, published by the Harbison-Walker Refractories Company. In particular, attention is directed to pages 500 and 521 of this book. The glossary of this same book defines the words "key" and "key shape" in furnace construction, substantially as follows: the uppermost or the closing brick of a curved arch. It is a brick shape having six plane faces (two sides, two edges, and two ends), in which two faces (the edges) are inclined towards each other, and one of the end faces is narrower than the other.

In FIG. 1, there is shown a composite metal encased refractory brick and support structure therefore, according to the concepts of this invention. The composite metal encased refractory brick includes two identical refractory keys 11 and 12 to form a refractory body having opposed parallel end faces 13 and 14, the first of which is the hot face in service and the second of which is the cold face. Opposed parallel side faces 15 and 16 perpendicularly intersect the hot and cold faces. The other two planar faces taper inwardly from cold face to hot face. Unitary metal casing holds the two key brick 11 and 12 together. In FIG. 1, the metal case is shown to be a generally U-shaped member 17 having two downwardly-extending arms 18 and 19 and two upwardly-extending arms 20 and 21. The terminal edges 22 and 23 of the arms 18 and 19 are bent, and extend inwardly of the body or bodies of the two refractory keys. There is a preformed notch or slot across the faces of the key brick which is arranged to frictionally engage these fingers 22 and 23.

The upwardly-extending arms 21 and 22 are parallel and perpendicularly intersect the plane in which the upper extremities of the arms 18 and 19 reside. Opposed, horizontal, slot-like apertures 30 and 31 are formed through the respective arms 20 and 21. In FIG. 1, I have shown a small segment 32 of the arcuate interior surface of refractory vessel to be lined using shapes according to this invention. Extending outwardly from the surface of said section 32 is a lug 33. I have shown an L-shaped lug in FIG. 1. One arm is welded or otherwise defixed to the vessel surface, while the other extends outwardly at right angles to the surface and has an aperture 34 formed therethrough. A bolt or pin 35 is arranged to pass through the slots 30, 31, and aperture 34, whereby to hold the composite metal-encased key structure and the supporting structure together.

In FIG. 3, an alternative construction is shown, in which a pair of key refractories are held together by casing structure 42 similar in all respects to that arrangement set forth in FIG. 1, except more circular apertures 43 and 44 are formed through the upwardly-extending arms 45 and 46 as compared to the slots in the upwardly-extending arms of the structure of FIG. 1. With such an arrangement, it is preferred that the supporting lug 47, which is attached to a surface 48 of a shell of a vessel to be lined, has a slot 49 formed therethrough. Thus, the slot 49 can be adjustably aligned with the apertures 43 and 45 to allow adjustment of the composite shape before tightening in place.

Another alternative construction for the upwardly-extending arms is shown in FIG. 4. Such an arm 55 has an elongated aperture 56 formed therethrough; but, instead

of a smooth cut, at least one face of the material defining the slot is serrated as at 57. With this arrangement, the bolt, rod, or like connecting member 58 is fluted to provide better purchase between the arm and that connecting member 58.

FIG. 5 shows still another alternative combination of support structure and metal-cased refractory shape according to the concepts of this invention. A pair of key shapes 60 and 61 are held together by the downwardly-extending fingers 64 and 65 arranged to be frictionally engaged or held in complementary slots across the opposed sloping faces of the key shapes 60 and 61. The upwardly-extending arms 66 and 67 are similar in all respects to the upwardly-extending arms 20 and 21 of FIG. 1. However, the support structure 70, which is attached to the surface 71 of a portion of the shell of the vessel to be lined, is quite different from the lug or hanger construction of FIG. 1. In FIG. 5, the support structure consists of a base 72 which is welded or otherwise affixed to the surface 71. Outwardly extending from the base 72 is a leg 73 having a foot 74 extending at substantially right angles to the leg approximating parallel to the nearest surface of the base 72. This arrangement cooperates with the wedge-shaped steel or like piece 75 to hold the structure together. In service, the arms 66 and 67 are moved downwardly about the support structure 70, and the wedge 75 is driven between the opposed faces of the base 72 and foot 74 below edges 66A and 67A of the arms 66 and 67 to thereby rigidly friction-fit the metal cased key structure and the support structure together. In this arrangement, it is preferred that the arms 66 and 67 be spaced much closer to each other than shown for the arms 21 and 20 in FIG. 1, to assure there is no overhang of wedge 75 as would prevent adjacent brick in adjacent courses from being positioned against each other. Note, however, that even the arms 20 and 21 of FIG. 1 are also spaced inwardly of the opposed faces 15 and 16 of the keys 11 and 12. This is also to allow for room for the head of the bolt 35 on one end and a fastening member (not shown) on the other end.

It should also be noted that exterior surfaces of those portions of the case which overlie portions of side faces of the refractory should be flush with the uncovered portions of respective faces or be depressed somewhat. This of course requires forming complementary depressions in respective refractory faces.

Reference to FIG. 9, which is a schematic diagram of a metal blank for making the casing 17 of FIG. 1, provides a somewhat better idea of the degree of spacing of the arms 20 and 21, and 22 and 23. The dashed lines in FIG. 9 are fold lines, about which the arms 20, 21, 18, and 19 are bent, and about which the edges 22 and 23 are bent. Not only is it preferred that the arms 20 and 21 be spaced apart a distance less than the width of the hot face of the key brick from which they extend; but, likewise, the width of the arms 18 and 19 is preferably less than the width of the pair of key brick faces over which they lie, to again assure there is no overhang which would prevent adjacent brick from being placed in contact with each other.

FIG. 6 shows still another alternative construction according to this invention, in which a pair of key brick 80 and 81 are abutted against each other and over which metal casing 82 is placed. The downwardly-extending arms 83 and 84 and their associated fingers 85 and 86 are similar to like parts in FIG. 1. However, the upwardly-extending arms 87 and 88 are shown as separate pieces of metal which have been welded to that portion of the metal casing 89 which substantially covers the cold faces or ends of the key brick 80 and 81. Still further, a lug 90 has been welded in position between the arms 87 and 88. This lug serves to prevent bending of the bolt member 91 against which the lug 90 is arranged to abut. The complementary hanger or support structure is a U-shaped member 95. Its web 96 is arranged to be welded or other-

wise affixed to the metal shell of the vessel to be lined. The downwardly-extending arms 97 and 98 have apertures formed therethrough which are arranged to adjustably align with the slots formed through the arms 87 and 88. An end of the pin or bolt 91 is apertured to receive a cotter pin 99 to thereby hold the structure together.

The alternative construction of FIG. 7 is again comprised of a pair of substantially identical key brick 105 and 106. Metal casing 107 includes a pair of downwardly-extending arms and inwardly-bent fingers which serve to hold the key brick together. However, there are no upwardly-extending arms in this construction. Instead, the key brick have a preformed notch 108 formed through their respective hot faces. The passage thus formed when metal casing 107 is put in place and arranged to receive the horizontally-extending finger 109 of support structure 110. The base 111 of the support structure is arranged to be welded or otherwise affixed to the shell of the vessel to be lined in the same manner as the support structure of FIGS. 1, 3, 5, and 6. Spaced to one side of the slot 108 and extending outwardly from the exterior surface of the metal casing which covers the cold face of the key brick 105 and 106 is a lug 112. The lug 112 is of sufficient extent as to rest against the surface of the vessel to be lined when the shape support is placed on support structure 110. This is desirable in order to prevent wobbling of the shape. Of course, one could alternatively have two spaced parallel apertures formed through the cold faces of the key brick to mate with a pair of parallel fingers 109. It is preferred that the terminal end 109A be apertured or threaded in some manner arranged to coast with a cotter pin, nut, or like fastening device to hold the structure together.

From the foregoing discussion, we have specifically pointed out various structures utilizing the concepts of this invention, in which the downwardly-extending arms cover the tapering surfaces of a key shape and in which the upwardly-extending arms are parallel to opposed vertical or horizontal nontapering flat faces, and in which two key brick are joined together to make the resulting composite shape. It should be understood the refractory body could be a single unitary refractory body 120 as shown in FIG. 8. The pair of downwardly-extending arms 121 and 122 and their inwardly-extending fingers 123 and 124 are associated with the brick 120 in the same manner as shown for the composite refractory bodies above. Further, the upwardly-extending arms 125 and 126 can extend upwardly from the same edges as the arms 121 and 122 extend downwardly. Still further, while I have shown the case overlying the tapering sides of the shape (to obtain better purchase) they can overlie opposed flat side faces.

The shape of FIG. 10 consists of a refractory body 150 about which two U-shaped metal case sections 151 and 152 are frictionally affixed. The cases are welded at 153 and have an inwardly-extending protuberance 154 arranged to seat in a complementary depression formed in the body 150. Tabs 155 and 156 extend upwardly from the case sections. They each have two slots formed therethrough. With this arrangement it is not necessary that the tabs be positioned inwardly of the edges of the cold faces. (Note FIG. 11.) A series of the shapes 150 are shown attached to a surface 160 by attaching the tabs 155 and 156 between complementary support structure 161 by the segmentally staggered pins 162. The pins can be so staggered because of the two vertically spaced slots in each of the tabs 155 and 156 without concern about overhang of the pins 161 as might prevent abutting of adjacent shapes 150.

Having thus described the invention in detail and with sufficient particularity as to enable those skilled in the art to practice it, what is desired to have protected by letters patent is set forth in the following claims:

1. The combination of a lining and a vessel characterized by a generally circular or arcuate cross-section along

a substantial portion of a horizontal or nearly horizontal longitudinal extent, comprising a plurality of aligned series of lugs along said longitudinal extent interiorly of the vessel, said series of aligned lugs being spaced from each other about the circular or arcuate cross-section, the lugs constructed and arranged to adjustably hold a first type of key or wedge shaped brick body, a said first type of brick body fastened to each of said lugs, said first type of brick body comprised of partially metal-encased refractory brick, said brick body comprised of a refractory key shape having metal casing about at least a portion of its larger end, said casing having two downwardly-extending arms covering a portion of two opposed side faces of the brick body and extending from said larger end to a point intermediate the longitudinal extent thereof whereat respective opposed lower arms cooperate with the brick body to maintain said casing thereon, there being fastening structure extending outwardly from the large end of the brick body, said fastening structure attached to a said lug, sequential series of said first type of brick body in combination with each other holding between them in a wedged relationship a ring of a second type of brick bodies, said second type of brick bodies being of conventional key or wedge shape, thereby forming said lining in the generally circular or arcuate cross-section of the vessel.

2. The combination of a lining and a vessel characterized by a generally circular or arcuate cross-section along a substantial portion of a horizontal or nearly horizontal longitudinal extent, comprising a plurality of aligned series of lugs along said longitudinal extent, said series of aligned lugs being spaced from each other about the circular or arcuate cross-section, the lugs constructed and arranged to adjustably hold a first type of key or wedge shaped brick, a said first type of brick fastened to each of said lugs, said first type of brick comprised of the combination of a refractory key and metal casing, said refractory key being a refractory body having six plane faces, a set of two of said faces tapering towards each other and extending between an additional set of two parallel faces, the foregoing two sets of faces extending between two additional parallel faces which serve as the hot face and the cold face, the smallest of said faces being the hot face, a generally U-shaped case section having a pair of downwardly-extending arms terminating in inwardly-bent fingers, said arms lying flush against the tapering faces of said key and said fingers extending into the brick at a point intermediate the hot and cold faces and being frictionally engaged therein, an additional pair of spaced arms extending outwardly from the cold face of the key and connected to a said lug, sequential series of said first type of brick in combination with each other holding between them in a wedged relationship a ring of second type of brick, said second type of brick being of conventional key or wedge shape to form said lining in the generally circular or arcuate cross-section of the vessel.

3. The combination of a lining and a vessel characterized by a generally circular or arcuate cross-section along a substantial portion of a horizontal or nearly horizontal longitudinal extent, comprising a plurality of aligned series of lugs along said longitudinal extent, said series of aligned lugs being spaced from each other about the circular or arcuate cross-section, the lugs constructed and arranged to adjustably hold a first type of key or wedge shaped brick, a said first type of brick fastened to each of said lugs, said first type of brick comprised of the combination of refractory and metal casing, said refractory being a body having six plane faces, a set of two of said faces tapering towards each other and extending between an additional set of two parallel faces, the foregoing two sets of faces extending between two additional parallel faces which serve as the hot face and the cold face, the smallest of said faces being the hot face, a generally U-shaped case section having a pair of down-

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wardly-extending arms overlying a set of faces and terminating in inwardly-bent fingers, said fingers extending into said body at a point intermediate the hot and cold faces and being frictionally engaged in said brick, fastening structure extending outwardly from the cold face of the shape and fastened to said lugs, sequential series of said first type of brick in combination with each other holding between them in a wedged relationship a ring of second type of brick, said second type of brick being of conventional key or wedge shape to form said lining in the generally circular or arcuate cross-section of the vessel.

4. The combination of claim 3 in which said fastening structure is a spaced pair of arms extending outwardly from said cold face, said spaced arms each having an elongated slot formed therethrough aligned with the slot in the other arm.

5. The combination of claim 4 in which at least a portion of the edge defining said slots is serrated.

6. The combination of claim 4 in which said fastening structure arms are integrally formed from a common sheet of metal with said first case section.

7. The combination of claim 3 in which said first case section consists of a U-shaped channel-like member comprised of a web extending between two unidirectionally extending arms terminating in oppositely directed fingers, said web lying across the cold face and the arms extending down the tapering faces of said body, outer surfaces of said arms being flush with the uncovered portions of said faces, said fingers being in a plane substantially parallel with the web and being frictionally engaged in said body of refractory.

8. The combination of claim 3 in which said case section is comprised of two U-shaped metal case pieces which cover said two sets of faces from a position contiguous to the cold face to a position intermediate the hot and cold faces.

9. The combination of claim 8 in which said two U-shaped case pieces overlap and are affixed to each other to frictionally engage the refractory body.

10. The combination of claim 8 in which a portion of each of the U-shaped cases is deformed to grippingly seat in complementary means formed in the refractory body.

11. That method of lining a vessel which is characterized by a generally circular or arcuate cross-section along a substantial portion of a horizontal or nearly horizontal longitudinal extent without the necessity of temporary

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support structure, comprising the steps of fastening a plurality of aligned series of lugs along the longitudinal extent of said generally circular or arcuate portion of the vessel, such series of aligned lugs being spaced from each other about the circular or arcuate cross-section, the lugs constructed and arranged to adjustably hold a first type of key or wedge shaped brick, fastening said first type of brick to said lugs in the following manner: fastening one or more of said first type of brick to said lugs in a first series, said series to which the first of the first type of brick are fastened capable of, in combination with additional of said first type of brick attached to lugs in a next adjacent series to hold between them in a wedged relationship a ring of a second type of brick, said second type of brick being of conventional key or wedge shape, laying up a group of such second types of brick against the first type of brick in said first series, attaching another of said first type of brick and adjusting it so that the second type of brick are rigidly affixed in an arcuate pattern adjacent the vessel shell, rotating the vessel to place additional of said arcuate or circular cross-section adjacent the bottom, laying additional of said second type of brick and wedging them in place by adjustably securing additional of said first type of brick to another of said series of lugs, continuing installation of first and second type of brick together with the rotation of the vessel until the generally circular or arcuate cross-section of the vessel is lined.

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FRANK L. ABBOTT, *Primary Examiner*.

ALFRED C. PERHAM, *Examiner*.