July 7, 1964 W. T. TREDENNICK ETAL 3,140,333

UNIVERSAL CIRCLE LADLE BRICK

Filed Feb. 1, 1961

FIG. 2

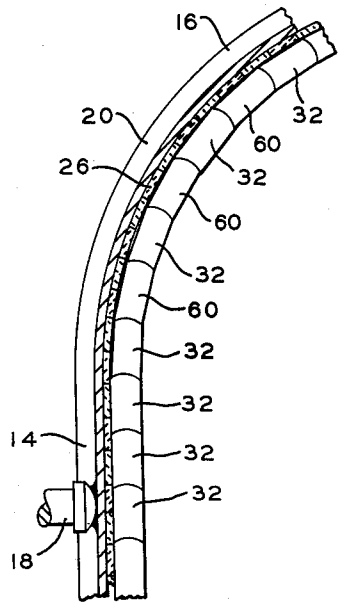


FIG. 1

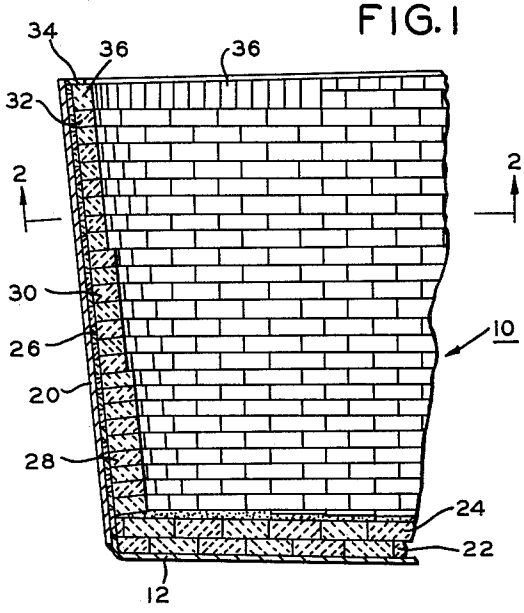


FIG. 3

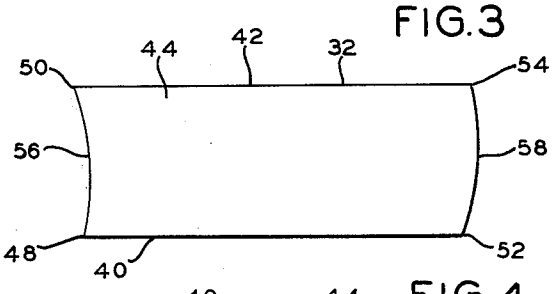


FIG. 4

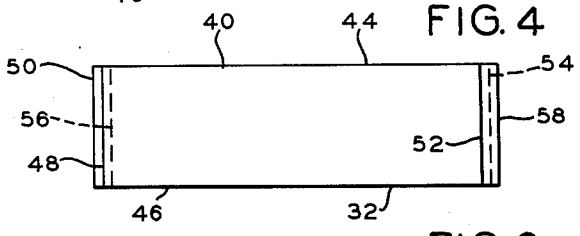


FIG. 5

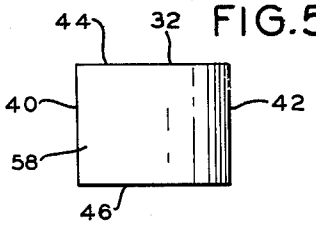
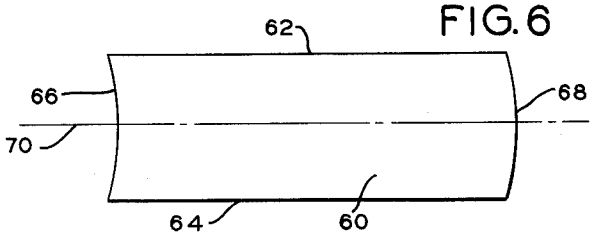


FIG. 6



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UNIVERSAL CIRCLE LADLE BRICK

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This invention relates to refractory block linings in ladles for molten steel, and the blocks for such linings.

Ladles for receiving molten steel require a refractory lining which must conform to the shape of the ladle and prevent the molten steel from penetrating to the outer metal sheath of the ladle. The lining must be able to withstand widely fluctuating temperatures and erosive action of molten steel and slag. The lining must remain in place while the ladle is tilted about its supporting trunnions, and must withstand numerous changes in temperature. Also, the lining must be capable of being taken out for repair or replacement.

It is necessary to build the lining in the form of a wall of individual refractory blocks. This raises the problem of utilizing a set of blocks which will provide a close-fitting wall which requires a minimum of differently shaped blocks to complete the lining. The lining should be made from blocks which can be laid easily and quickly by relatively unskilled labor. The problem is complicated by the fact that the ladles not only have conically curved side walls, but in many instances include straight side walls interposed between conically curved ends.

Ladles lined with blocks which are curved convexly at one end and concavely at the other end are shown in U.S. Patent 2,818,248. The blocks shown in the above-identified patent are made in a 45 and 60 series. In the 45 series, it takes a minimum of thirty blocks to make a ladle having a diameter of six feet eight inches and a maximum of forty-five blocks to make a ladle having a diameter of ten feet. In the 60 series, it takes a minimum of forty-six blocks to make a ladle having a diameter of ten feet and a maximum of sixty blocks to make a ladle having a diameter of thirteen feet four inches.

Thus, it will be seen that the blocks as shown in the above-identified patent are capable of being utilized in conjunction with half size blocks to form ladles having a minimum and maximum diameter. In the above mentioned patent, the half size and the whole size blocks are provided with end faces having the same angular relationship. That is, the chordal planes through the cylindrically curved ends of each form of block have the same angular relation.

In accordance with the present invention, I have found that almost any size diameter ladle can be lined by intermixing blocks having front and back faces of the same length. In doing so, I provide the blocks with end faces so that chordal planes through the cylindrically curved ends of each form of block do not have the same angular relation. In this manner, I am able to vary the diameter of the ladle without being limited to the very narrow range between the minimum and maximum number of blocks as exists when practicing the invention set forth in the above enumerated patent.

It is an object of the present invention to provide a novel lining for ladles for molten steel and the like.

It is another object of the present invention to provide a novel lining comprised of blocks having curved end faces and side faces of the same length, wherein chordal planes through the curved ends of each form of block do not have the same angular relation.

It is another object of the present invention to provide a novel set of refractory blocks for lining molten steel ladles and the like wherein the diameter of the ladle can be substantially any diameter desired.

Other objects will appear hereinafter.

For the purpose of illustrating the invention there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a partially broken away section of a ladle for molten steel with a lining incorporating the present invention, the section being taken along a vertical plane normal to the trunnion axis for the ladle.

FIGURE 2 is a sectional view taken along the line 2—2 in FIGURE 1.

FIGURE 3 is a top plan view of one form of lining block in accordance with the present invention.

FIGURE 4 is a side elevational view of the block shown in FIGURE 3.

FIGURE 5 is an end elevational view of the block shown in FIGURE 3.

FIGURE 6 is a top plan view of another form of block adapted to be mixed with the block shown in FIGURE 3 for making the lining of the present invention.

Referring to the drawings in detail, wherein like numerals indicate like elements, there is shown in FIGURE 1 a partially broken away section of a ladle designated generally as **10**.

The ladle **10** for molten steel and the like has a sloped bottom wall **12** and opposite straight wall portions **14** which merge into opposite conically curved ends **16**. A trunnion **18** extends from one of the straight wall portions **14** and a corresponding trunnion (not shown) extends from the opposite straight wall portion (not shown).

The straight and curved sides of the ladle **10** taper outwardly from bottom to top in order to facilitate removing hardened metal formed in the ladle. A taphole (not shown) is provided in the bottom of the ladle **10** with a suitable nozzle and stopper to fill or empty the ladle **10** as required. The ladle **10** is also provided with a slag spout (not shown) on its upper rim.

A metal shell **20** extends around the bottom and sides of the ladle **10**. A refractory bottom safety lining **22** and a refractory working floor lining of blocks **24** are provided on that portion of the shell **20** defining the bottom of the ladle **10**. A working lining of relatively thick blocks **28** are arranged against the side safety lining of blocks **26**. The working lining of relatively thick blocks **28** extends upwardly from the working floor lining of blocks **24** partway up the side of the ladle **10**, thereby covering the area of greatest wear.

A working lining of thinner blocks **30** are provided further up the sides of the ladle **10** against the side safety lining of blocks **26** as shown more clearly in FIGURE 1. A working lining of thin blocks **32** is laid next to the side safety lining of blocks **26** above the working lining of thinner blocks **30** as shown more clearly in FIGURE 1.

A plate **34** is secured to the metal shell **20** and extends over the side safety lining **26**. The plate **34** also extends partly over a final course of conventional blocks **36** which are positioned on the top course of working lining thin blocks **32**. All of the blocks are made of kiln-fired refractory clay. The working lining blocks **28–32** are laid in continuous multiple spirals substantially from the bottom of the top of the ladle **10** as shown in FIGURE 1.

As shown more clearly in FIGURE 3, the blocks **32** are provided with a straight front face **40** and a straight back face **42** which are parallel to one another. As will be made clear hereinafter, the front face **40** is shorter in length than the back face **42**. The block **32** is provided with parallel horizontal top and bottom faces **44** and **46**. The front, back, top, and bottom faces cooperate with an arcuate end face **56** to form vertical block edges **48** and

50. The front, back, top and bottom faces cooperate with the arcuate end face 58 to define the vertical block edges 52 and 54.

The arcuate end faces 56 and 58 are respectively concave and convex. The radius of curvature for the arcuate end face 56 is identical to the radius of curvature for the arcuate end face 58. However, as shown more clearly in FIGURE 3, the arcuate end faces 56 and 58 define arcs of circles having their centers on opposite sides of the center line which is equidistant from the front face 40 and the back face 42.

Block 32 as shown in FIGURES 3–5 is identical with the block set forth in the corresponding figures in U.S. Patent 2,818,248. Accordingly, it is not deemed necessary to explain in detail the manner of computing the length of the faces of the block 32. The following figures are exemplary of the face dimensions of a 60 series block 32: front face—7.936 inches; back face—8.250 inches; thickness between front and back faces—3 inches; thickness between top and bottom faces—3 inches; and radius of curvature for arcuate end faces—7 inches. It will be noted that the radius of curvature is greater than the thickness between the front and back faces.

A lining in accordance with the present invention is made by intermixing the blocks 32 with blocks 60. A top plan view of block 60 is shown in FIGURE 6. Block 60 is provided with a vertical back face 62 which is parallel to the vertical front face 64. The block 60 is also provided with parallel horizontal top and bottom faces. The block 60 is provided with arcuate end faces 66 and 68. The arcuate end face 66 has a radius of curvature identical to the radius of curvature of arcuate end face 68.

The block 60 differs from the block 32 by providing front and back faces 64 and 62, respectively, which have the same length. Also, the arcuate end faces 66 and 68 define arcs of circles whose center lie along the center line 70. In other words, the block 60 is symmetrical along its center line 70.

As pointed out in the above-identified patent, there is an important interrelationship between the radius of curvature of the end faces of the blocks and the thickness of the blocks. The blocks 60 are preferably provided with front and back faces having a length equal to the length of the back face on the blocks 32. The radius of curvature for the end faces 66 and 68 is identical with the radius of curvature for the end faces 56 and 58.

As shown more clearly in FIGURES 1 and 2, the blocks 60 and 32 are intermixed in the formation of the lining for the ladle 10. The intermixing of the blocks 32 and 60 enables a wide variety of diameters for the ladle 10 to be obtained. The curvature of the end faces on the blocks 32 and 60 provides sufficient keying effect so as to form a solidly interlocked lining. It should be noted that the lining made in accordance with the blocks of the present invention does not utilize mortar.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

We claim:

1. A ladle for molten steel comprising a vessel defined by a metal shell having straight side wall portions merging tangentially with conically curved lengths, a lining of refractory blocks laid in successive courses within said shell, some courses being built of a set of two different forms of block, the first form of block having flat parallel top and bottom faces, opposite cylindrically curved ends of equal radius of curvature but respectively concave and convex, and front and back faces which intersect the curved surfaces of the ends, the back face being longer than the front face so that a series of such blocks extend in a curve conforming to the curvature of said shell, and the second form of block having identical front and back faces corresponding to the length of the back face of said first mentioned form of block, said second form of block having arcuate end faces respectively concave and convex, and the center of curvature forming the arcuate end faces of said second form of block lying along a center line between the front and back faces of said second form of block.

2. A ladle in accordance with claim 1 wherein the radius of curvature for the end faces of said first form of block is identical with the radius of curvature for the arcuate end faces on said second form of block, said radius of curvature being at least as great as the distance across the front and back faces of the largest block of said first and second forms of block.

3. A ladle in accordance with claim 2 in which chordal planes through the curved end faces of each first form of block define arcs of circles having their center on opposite sides of a center line disposed equidistant from the front and back faces of each first form of block.

4. A curved wall formed at least in part from a set of refractory blocks for lining molten steel ladles and the like, all of said blocks having flat parallel top and bottom faces, a first form of block having opposite cylindrically curved end faces respectively convex and concave, flat parallel front and back faces intersecting said curved end faces on said first form of block, the back face on said first form of block being slightly greater in length than a front face on said first form of block, a second form of block intermixed with said first form of block in the formation of courses of said lining, said second form of block having front and back faces identical in length with the back face on said first form of block, arcuate end faces on said second form of block being respectively concave and convex and having a radius of curvature along a center line equidistant from the front and back faces on said second form of block, the radius of curvature for the end faces on said first form of block being equal to the radius of curvature of the end faces on said second form of block, said set including relatively thick blocks and thinner blocks, said radius of curvature being at least as great as the distance across the front and back faces of the largest block of said first and second forms of blocks, such thickness being measured between front and back faces on said blocks, and a concave end face on said second form of block being juxtaposed to a convex end face on said first form of block.

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