United States Patent

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[54] **LADLE LINING**
5 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **52/249,** 110/1, 266/43
[51] **Int. Cl.** **C21b 7/06**
[50] **Field of Search** ..... 52/245, 246, 612, 249, 609; 110/1 A, 1 C; 266/36 P, 36 R, 43, 40, 39, 24

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ABSTRACT: A ladle having a curved conical sidewall provided with a lining comprising stacked courses of refractory blocks disposed with horizontal top and bottom faces and provided with parallel front and back faces inclined at substantially the same angle as the ladle sidewall to provide a lining face which is smooth and continuous.

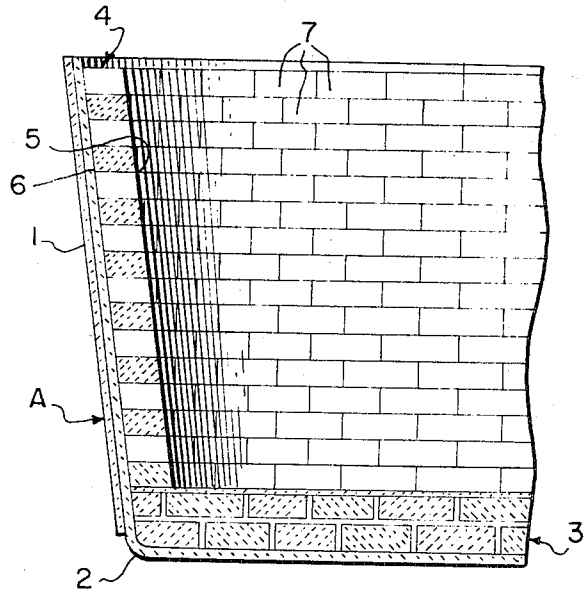


Fig. 1.
(PRIOR ART)

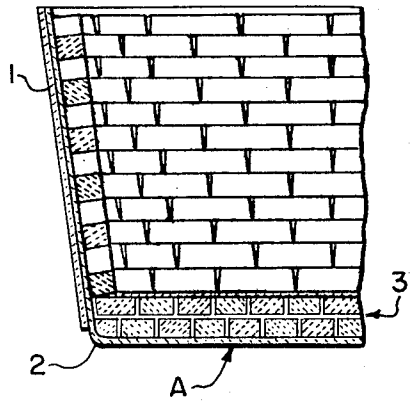


Fig. 2.

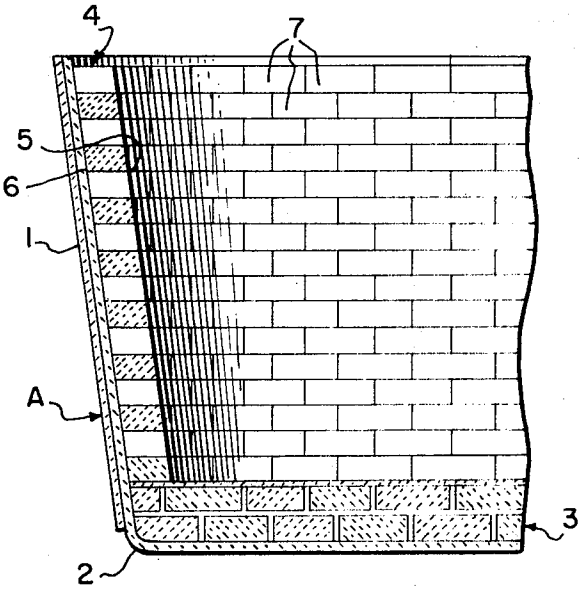


Fig. 3.

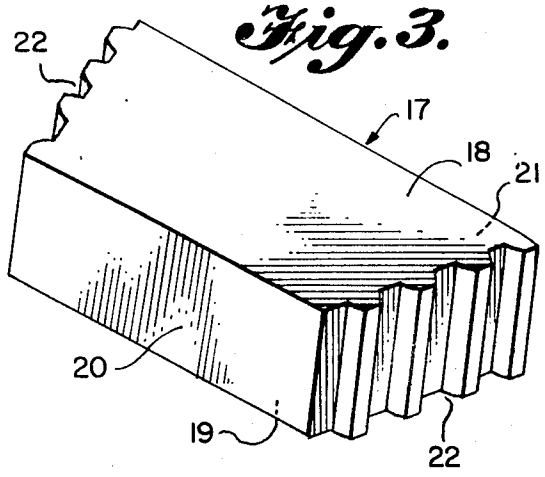


Fig. 4.

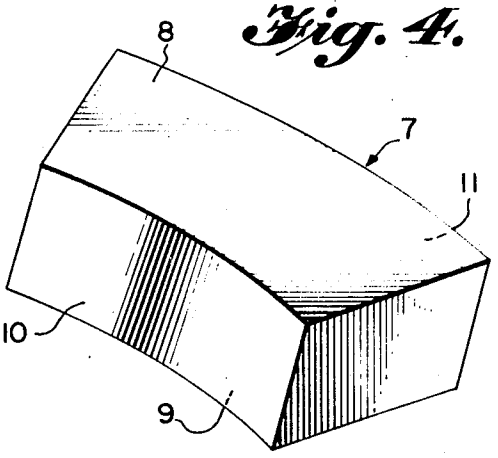
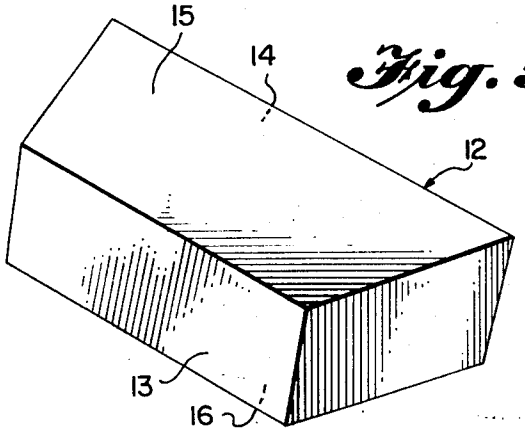


Fig. 5.



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LADLE LINING

This invention relates generally to refractory blocks and more particularly to an improved construction and method of arranging such blocks to provide linings in ladles as used for molten steels and other materials.

The ladle of the present invention will be understood to be especially adapted for use in metallurgical processes involving the production of steels or alloys, such as by electric furnaces, and includes a working lining comprising a plurality of specifically constructed refractory blocks arranged in a manner to provide a ladle lining of vastly improved stability and increased useful working life. The concept of this invention will be particularly appreciated when applied to those ladles having a diameter less than approximately 90 inches wherein a significant shortcoming is presently evident.

Ladles for containing molten steel or alloys are provided with a refractory lining which must necessarily be arranged within the confines of the circular or curved sidewall of the ladle in a manner most likely to prevent the molten metal from penetrating to the outer metal shell of the ladle. The lining must perform this mission while being subjected to extreme fluctuating temperatures and the erosive action of the molten metal being poured into and out of the ladle and must withstand this action for as many successive heats as possible in order to reduce the frequency of downtime required for repair or replacement of the lining.

Alternate methods of lining ladles with refractory block include using either soldier courses or a circular arrangement and several shapes of refractory block have been utilized in prior linings in efforts to achieve a more efficient installation, including straight, circle, universal and chord circle blocks. More recently, an improved interlocking block has been found to produce an advantageous ladle lining and forms the subject matter of my earlier patent (U.S. Pat. No. 3,394,521, issued July 30, 1968). It has been acknowledged by those skilled in the art that this latter block structure yields a lining superior to those utilized heretofor which may be attributed to the effective blockage against outward flow of molten metal offered by the novel interlocked structure. However, a shortcoming has been observed, which also is apparent when using other prior art blocks in lining the conically curved sidewalls of ladles. The referenced problem is attributed to the inclination of the curved ladle sidewall or shell against which the refractory blocks are positioned. This inclination exists within the range of 4°–10° from the vertical and will be understood to significantly affect the installation of the lining refractory blocks, which have previously comprised vertical front and rear faces and horizontal top and bottom walls, whether these surfaces have been curved or straight. With such an arrangement, it will follow that if the blocks are laid flat, that is with the top and bottom walls horizontal, then each succeeding course will be set back a significant distance with respect to the next lowest course such that a ledge will extend outwardly into the ladle between each pair of courses thereby significantly reducing the effective thickness of the lining. The effect of this ledge will additionally be a consideration in view of the residue removal operation to which the ladle will be subjected in the case of an alloy plant. This periodic operation involves the mechanical removal of solidified alloy and slag from the interface of the lining and is usually accomplished with a power chisel tool, such as a jack hammer and it will be appreciated that in the case of the above-described lining that the plurality of ledges projecting into the ladle center will be struck by such a tool and removed along with the alloy and slag, thus reducing even more the effective amount of refractory lining present.

In order to correct the above arrangement leading to a reduction in effective thickness, many linings have been constructed to reduce corbelling of the refractory blocks such that the front and back faces of all the blocks are disposed in two common planes, each parallel to the inclined sidewall of the ladle shell. In this manner it will be understood that the top and bottom planar walls of each block, which are perpendicular to the front and back faces, will be disposed in planes inclined with respect to the horizontal or sloping downwardly from the front face to the shell wall. The corbel effect is thus reduced in view of the placement of a plurality of planar surfaces in a circular manner and in a sloping plane. This prior art installation results in a lining which normally is most unstable and yields a triangular-shaped opening between the ends of each pair of adjacent blocks and which obviously leads to defeat of the very purpose of a ladle lining namely, the prevention of passage of the molten metal to the back face of the lining and the adjacent ladle shell. This relationship is due to the ladle sidewall inclination and the fact that each succeeding course of blocks is positioned to place its outer vertical face within a circle having a radius larger than that of the circle within which the preceding course of blocks is positioned. Stated alternatively, the corbel effect is reduced due to the circular placement of the outer edge of each block top and bottom wall in a plane which is lower than the plane of the inner edge of these walls.

The construction of the present lining is further enchanced by the use of a bloating type of block. The bloating type may be classified as a low duty fireclay brick having high bulk density and low apparent porosity. While brick of higher refractoriness and lower reheat expansion characteristics are sometimes used for lining ladles, they are subject to possible joint penetration and hence may lead to difficulty in skull removal. This condition is lessened when bloating-type brick is used because of its inherent ability to expand at the surface at steelmaking temperatures thus sealing the joints against metal and slag penetration and forming virtually a monolithic lining. Life of the ladle linings is, therefore, more consistent when bloating brick are used and less time is generally required for lining repairs or patching. Also, operation with fewer ladles may be possible without delay in tapping heats with the consistently high ladle life normally obtained from bloating-type brick.

Accordingly, one of the primary objects of the present invention is to provide an improved ladle lining wherein the ladle includes a curved conical sidewall or shell and the lining comprises a plurality of refractory blocks disposed in a plurality of stacked courses, each block constructed to provide a substantially continuous contact between juxtaposed top and bottom walls thereof, as well as a single continuous surface on both the front and back faces of the lining.

Another object of the present invention is to provide an improved ladle lining including a plurality of refractory blocks each of which is provided with planar and parallel top and bottom walls, and front and rear faces which are parallel and inclined substantially in the same degree as the inclination of the ladle sidewall.

Another object of the present invention is to provide an improved method of lining ladles having a conically curved sidewall including the steps of stacking a plurality of refractory blocks thereagainst and wherein each block is constructed to permit placing the blocks in a horizontal plane yet providing an inclined but smooth or planar front and back face to the completed lining.

With the above and other objects in view which will more readily appear as the nature of the invention is better understood, the invention consists in the novel construction, combination and arrangement of parts hereinafter more fully described, illustrated and claimed.

A preferred and practical embodiment of the invention is shown in the accompany drawing, in which:

FIG. 1 is a vertical section, partly broken away, and illustrates a typical ladle according to the prior art.

FIG. 2 is an enlarged view similar to FIG. 1 and discloses the ladle lining of the present invention.

FIG. 3 is a top perspective view of one form of refractory block according to the present invention.

FIG. 4 is a top perspective view of another embodiment of the present invention.

FIG. 5 is a top perspective view of a further embodiment of the present invention.

Similar reference characters designate corresponding parts throughout the several figures of the drawing.

Referring now to the drawing, particularly FIG. 2, the present invention will be seen to comprise a ladle, generally designated A, which includes an outer metal shell 1 constructed with a conically curved configuration as is well known in the art. The instant arrangement will be particularly appreciated when applied to the metallurgical environment involving ladles having a diameter approximately between 57 and 90 inches. This relatively small diameter results in a ladle wall of small radius and thus a substantially sharp curvature and an emphasis of the corbel effect. Combined with this curvature is a ladle wall inclination of between 4°–10°.

Provided adjacent the inner surface of the metal shell 1 is the usual refractory safety lining 2 which also extends across the bottom of the ladle. A working floor lining 3 is provided across the bottom of the ladle and forms the horizontal base upon which the working side lining, generally designated 4, is installed. The result of the referenced corbel effect is illustrated in the prior art arrangement shown in FIG. 1 which indicates in an exaggerated manner the unstable or irregular placement of stacked courses of conventional refractory blocks in a ladle having a conically curved sidewall and clearly illustrates the irregular spaces thus formed between the stacked blocks and which leads to a relatively short life for the lining in view of the allowable penetration of molten metal and slag therebetween.

The ladle lining as disclosed in FIG. 2, according to the present invention, will be seen to provide a lining face, generally designated 5, comprising a smooth continuous curved and inclined surface extending from the working floor lining 3 to a point adjacent the top of the ladle and likewise provides a similarly disposed lining back, generally designated 6, which will be seen to be parallel to the lining face 5 and forms a continuous curved and inclined surface in full contact with the juxtaposed surface of the refractory safety lining 2.

It will be understood that the lining 4 as shown in FIG. 2 illustrates the basic concept of the present invention and the arrangement shown therein would generally apply even though utilized in combination with refractory blocks having various configurations when viewed in top plan. In this figure, a modified circle block is shown installed in the ladle A which block is illustrated on an enlarged scale in FIG. 4. The circle block, generally designed 7, will be seen to include a top wall 8 and bottom wall 9 comprising congruent planar surfaces disposed parallel to one another and having arcuate inner and outer edges. The front face 10 and back face 11, on the other hand, comprise curved surfaces, the latter of which substantially corresponds to the approximate curvature of the ladle shell 1. The important feature of the present invention resides in the angular disposition of the front face 10 and back face 11 with respect to the top and bottom walls of the block as will be seen most clearly in FIG. 2, wherein it is quite evident that the front and back faces, although parallel to one another, are inclined outwardly an amount approximately equal to the inclination of the ladle shell 1 with respect to the horizontal. From the foregoing, it will be understood that the refractory block used in the subject lining comprises a transverse cross section having a configuration describing a parallelogram such that when each course of these blocks is installed with a top and bottom wall in a horizontal plane, the front and back faces thereof will be disposed parallel to the shell 1. The above-described structure insures that the outside and inside edges of both the top and bottom walls of the block are disposed in a common horizontal plane and thereby precludes the irregular or unstable disposition of the assembled plurality of courses of blocks heretofore described as producing the corbelling effect.

In the prior art installation of FIG. 1, the conventional rectangular cross section configuration of the refractory blocks clearly points out the resultant assembly wherein the top and bottom walls of all the blocks are disposed normal to the ladle shell and thus in a plane which is not parallel to the horizontal such that the inside and outside edges of each refractory block are disposed in two different horizontal planes thereby producing a corbelling effect and the attendant unstable or irregular spacing between the plurality of blocks.

Although the modified circle block 7 of FIG. 4 would provide the most intimate contact between the back face 11 thereof and the adjacent ladle shell 1, it will be understood that any of the other well-known types of blocks may be constructed according to the present invention. This will include universal, straight, chord circle and tongue and groove or interlocking blocks. A modified chord circle block 12 is shown in FIG. 5 having a planar and parallel front face 13 and back face 14 and a planar and parallel top wall 15 and bottom wall 16 which latter walls define a trapezoidal configuration in plan. Again, as in all blocks according the present concept, the configuration of a transverse cross section of the block is that of a parallelogram with the front and back faces inclined with respect to the horizontal, an amount approximately that of the ladle shell inclination.

A tongue and groove, or interlocking block 17, is shown in FIG. 3 and includes planar and parallel top and bottom walls 18 and 19 respectively, together with front and back faces 20 and 21, which latter faces are inclined in a manner similar to the corresponding faces of the other described blocks to provide the cross-sectional configuration of a parallelogram. In this interlocking block 17, it will be understood that the tongue and groove arrangement at the ends of the block will be disposed parallel to front and back faces 20 and 21, respectively.

The manner of installing the lining 4 of the present invention will be apparent in view of the foregoing description. The lowermost course of refractory blocks is positioned upon the top of the horizontally disposed working floor lining 3 with the back face of each refractory block being abutted against the adjacent safety lining or ladle shell and each subsequent course of block is positioned upon the next lowest course with the edges of each top and bottom wall contacting one another such that a smooth continuous lining face 5 is produced resulting in a lining face or surface parallel to the inclined surface of the ladle shell and yielding a working side lining 4 of the most stable nature without any corbelling effect.

I claim:

1. A ladle comprising a conically curved side shell inclined upwardly and outwardly from a horizontal base lining, said side shell substantially circular in plan and inclined from the vertical at a substantially fixed angle between approximately 4°–10, said shell having a diameter of less than approximately 90 inches, a working side lining disposed adjacent substantially the entirety of the interior surface of said shell, said side lining including a plurality of vertically stacked courses of refractory blocks, each said course in turn including a plurality of laterally adjacent refractory blocks, said blocks of vertically adjacent courses of congruent configuration, each said block having a planar and congruent top and bottom walls parallel to one another, parallel front and back faces on each said block both angularly disposed with respect to said block top and bottom walls, each said block having a pair of end walls disposed in vertical planes, and said block top and bottom walls are parallel to the horizontal plane of said base lining while said angularly disposed front and back faces are vertically inclined an amount substantially corresponding to said inclination of said shell side from the horizontal, whereby the lateral edges of said front faces of adjacent blocks are contiguous throughout said side lining.

2. A ladle according to claim 1, wherein said blocks are arcuate in plan.

3. A ladle according to claim 1, wherein said blocks are trapezoidal in plan.

4. A ladle according to claim 1, wherein said blocks are provided with an interlocking tongue and groove structure on the juxtaposed ends thereof.

5. A ladle according to claim 1, wherein a refractory safety lining is disposed between the back face of said lining and said shell.