Aug. 31, 1965 W. SIECKMAN ETAL 3,203,688

APPARATUS FOR DEGASSING MOLTEN METAL

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Fig. 1

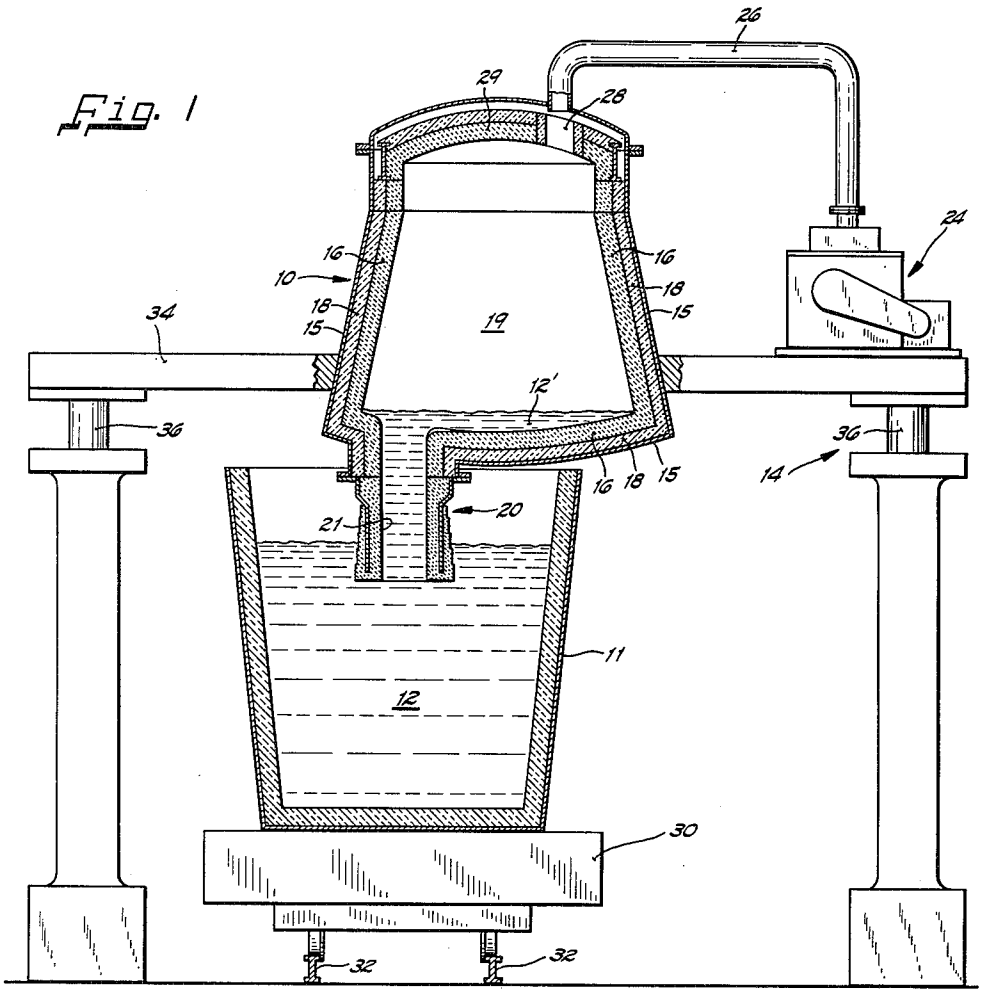


Fig. 3

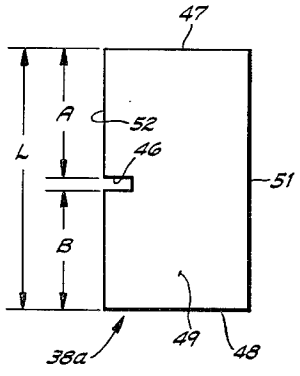
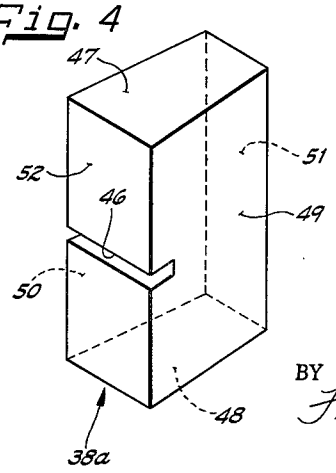


Fig. 4



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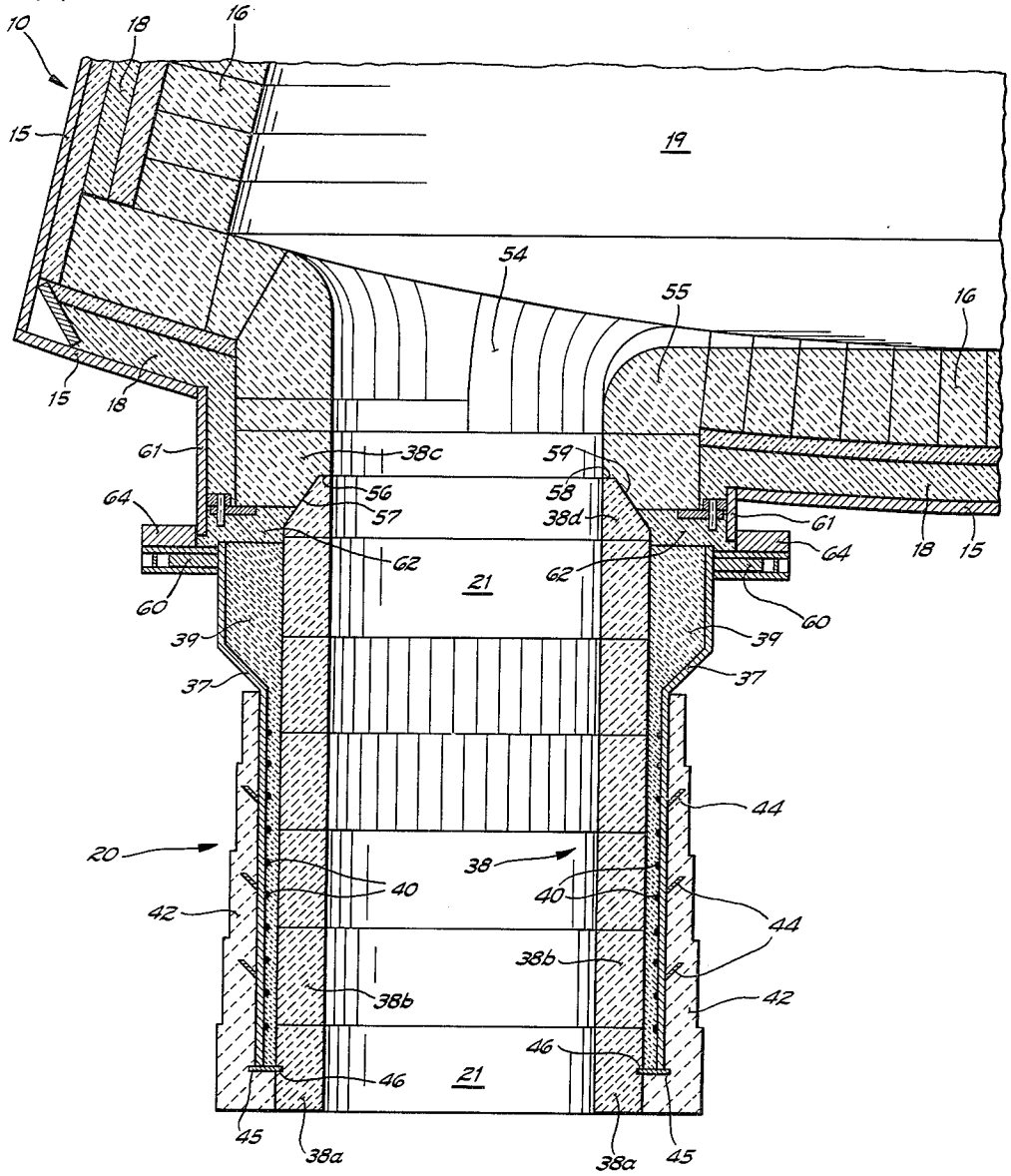
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Fig. 2



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APPARATUS FOR DEGASSING MOLTEN METAL

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6 Claims. (Cl. 266—43)

This invention relates to apparatus for the vacuum degassing of molten metals and, more particularly, to portions of the refractory lining thereof.

The production of certain steel alloys requires the reduction of such elements as oxygen, carbon and hydrogen. Because chemical reactions involving these elements have a gas phase and can be made to occur at reduced pressures, their removal can be accomplished expeditiously by treating the melt in a vacuum chamber.

The type of vacuum degassing apparatus used to illustrate the preferred embodiment of the instant invention is one wherein a vacuum chamber is disposed above a ladle of molten metal and the two are arranged for relative movement toward and away from each other. A nozzle extends downwardly from the lower end of the vacuum chamber so that upon movement of the chamber and the ladle toward each other, the reduced pressure in the chamber draws molten metal through the nozzle whereupon degasification takes place due to the action of the vacuum therewithin. Upon relative movement of the chamber and the ladle away from each other, molten metal flows out of the nozzle to intermix with the remaining metals in the ladle. If desired, a new portion of the melt may be redrawn into the chamber by again relatively moving the vessel and ladle toward each other. This process is repeated until the desired degree of degasification has been achieved.

Because of the eroding effect of the molten metal as it moves into and out of the degassing chamber through the nozzle, the nozzle lining is worn away and must be replaced more often than the remainder of the vessel lining. This requires that the nozzle be removable from the vessel and easily relined.

An object of the instant invention is to provide a course of refractories for the lining of a nozzle used to conduct molten metal to a vacuum degassing chamber which provides additional strength at the junction between the disconnectable metallic shells of the nozzle and chamber.

Another object of the invention is to provide a course of refractories for the lining of a nozzle used to conduct molten metal to a vacuum degassing chamber which allows the nozzle to be relined and affixed to an existing chamber without the necessity for maintaining close tolerances.

These and other objects and advantages of the invention will become more apparent from the detailed description of the invention taken with the accompanying drawings in which:

FIG. 1 is a side elevational view, partly in section, of the vacuum degassing apparatus incorporating the instant invention;

FIG. 2 is a cross sectional view illustrating the details of the nozzle assembly; and

FIGS. 3 and 4 show one of the refractories of the nozzle illustrated in FIG. 2.

In general terms, the invention comprises refractories for use in the lining of a metallic nozzle employed to conduct molten metal to and from a vacuum degassing chamber. According to one aspect of the invention, a high alumina refractory is provided for use at the inlet of said nozzle and has a hexahedronal shape with four

rectangular side surfaces and a pair of trapezoidal end surfaces. One pair of the side surfaces is parallel and the other pair is nonparallel wherein one of the parallel surfaces is wider than the other and has a transversely extending groove parallel to the end surfaces and intersecting the pair of non-parallel side surfaces. The groove is also a predetermined greater distance from one of the end surfaces than the other.

According to another aspect of the invention, the inlet end of the metallic nozzle is provided with a metallic ring affixed thereto and lying in a plane substantially perpendicular to its axis. In addition, each of the refractories defining the inlet end of the nozzle lining is provided with a notch intermediate its ends and embracing the metallic ring to provide additional support for the refractories thereabove in the nozzle lining. Also, the notch is located a predetermined greater distance from one end of the refractory than the other so that variations in the lengths of the refractories in the nozzle lining resulting from normal manufacturing tolerances, may be compensated.

According to another of its aspects, the invention comprises a first course of refractories disposed about the inner end of the nozzle and having a notch formed in their lower inside edge to define a continuous groove in the upper end of the nozzle bore. The inner end of each of the refractories in the adjacent course being formed to cooperatively engage the groove to provide therewith a lapp-butt joint at the juncture of the nozzle and the chamber.

Referring now to the drawings in greater detail, FIG. 1 shows a vacuum degassing apparatus comprising a vessel 10, a ladle 11 containing molten metal 12 and a lifting mechanism 14 for supporting the vessel 10 and for lifting it vertically relative to the ladle 11. The degassing vessel 10 includes a steel shell 15 which encloses an inner refractory lining 16. A layer of heat insulating material 18 is disposed between the metallic shell 15 and the refractory lining 16 to minimize heat radiation losses from the vessel 10. The steel shell 15 provides a support for, and hermetically seals the chamber 19 defined by the relatively porous refractory lining 16. A nozzle 20 is affixed to the lower end of the vessel 10 and has a cylindrical bore 21 that communicates with the interior of the chamber 19.

An evacuating apparatus 24 is coupled to the chamber 19 of the vessel 10 by a conduit 26 which is connected in a hermetically sealed relation to the shell 15 adjacent an aperture 28 in the roof 29 of refractory lining 16. A car 30, movably mounted on rails 32 below vessel 10, is provided to support and position the ladle 11. The lifting mechanism 14 includes a platform 34 upon which the vessel 10 is affixed and a plurality of coordinated hydraulic rams 36 for moving the platform 34 and the vessel 10 vertically. Control of the hydraulic rams 34 is effected by an operator stationed at a remote location. While the vessel 10 is shown to be vertically movable in the illustrated embodiment, it will be appreciated that the device would operate equally as well if the vessel 10 were stationary and the ladle 11 movable.

Operation of the vacuum degassing apparatus will now be described. After the ladle 11 of the molten metal 12 has been positioned below the vessel 10, the latter is lowered until the nozzle 20 extends a predetermined distance below the surface of the melt 12. The evacuating apparatus 24 is then activated to produce a partial vacuum within the chamber 19. As a result of this difference in pressure between the interior of chamber 19 and the atmospheric pressure acting on the surface of melt 12, a portion of said melt, identified by the reference nu-

meral 12' to distinguish it from the main body of the melt 12, is forced upward through nozzle 20 and into chamber 19 where gases dissolved therein are drawn off by the operation of the partial vacuum. After this portion 12' of the melt 12 has been degassed for a predetermined length of time, the vessel 10 is raised thereby causing the melt 12' to discharge into the ladle 11 to produce a vigorous stirring within the remainder of the melt 12. The lower end of the nozzle 20, however, remains below the surface of the melt 12 to maintain the partial vacuum within the chamber 19. This process may then be repeated by successively lowering and raising vessel 10 until the desired degree of total degasification has been achieved.

Reference is now made to FIG. 2 which in greater detail shows the nozzle 20 to include a steel shell 37, an inner refractory lining consisting of a plurality of courses of high alumina refractories 38 and a layer of high alumina refractory mix 39 between the outer surface of the refractories 38 of the steel shell 37. A plurality of weld spots 40, formed by affixing small portions of welding material to the inner surface of the shell 37, are employed to help support the ram mix 39.

It will be recalled that the lower end of the nozzle 20 is to be dipped into molten metal which is at a very high temperature. In order to prevent the steel shell 37 from being damaged by contact with this molten metal, a refractory jacket 42 is disposed on the outer surface of the shell 37 and extends below its lower end and into contact with the lower course 38*a* of the refractories 38. The jacket 42 is formed by forcing a high alumina refractory ramming mix between a mold and the shell 37. A plurality of frustro-conical rings 44 are affixed to the outer surface of the steel shell 37 to help support the jacket 42 as well as to increase the leakage path for air around the surface of the steel shell 37.

An annular steel ring 45 is affixed to the lower end of the shell 37 in a concentric relation with the bore 21 of nozzle 20 and lying in a plane substantially normal to its axis. In addition, each of refractories 38*a* in the lower course of the nozzle lining 38 is provided with a groove 46 which engages the inner edge of the ring 45 to provide support for the remainder of the refractories 38 thereabove.

As seen more specifically in FIGS. 3 and 4, each of the refractories 38*a* is a hexahedron having a pair of trapezoidal end surfaces 47 and 48, a pair of non-parallel side surfaces 49 and 50 and parallel inner and outer surfaces 51 and 52 respectively. It can be seen that outer surface 52 has a transversely extending groove which is parallel to the end surfaces 47 and 48 and intersects each of the side surfaces 49 and 50.

The side surfaces 49 and 50 of each refractory 38*a* is in abutment with the side surfaces of the adjacent refractories 38*b* so that each is wedged in place. The ring 45 must therefore be split so that it may be placed in the substantially annular groove formed around the periphery of the refractories 38*a*.

With reference to FIG. 3, in the preferred embodiment, the distance A from one end surface 47 of the refractories 38*a*, to the edge of groove 46, has a predetermined greater value than the distance B from the other end surface 48 to the other edge of the said groove. The purpose of this eccentricity is to compensate for normal manufacturing tolerances in the remainder of the refractories 38, as will be illustrated by the following example with reference to FIG. 3. Assume that the total length L of the refractory 38*a* is 8 inches the dimension A is 3⅞ inches and the dimension B is 3 13/16 inches. As a result, the distance between the lower surface of the next succeeding course of refractories 38*b* and the ring 45 may be between 3 13/16 and 3⅞ and still accommodate the lower course of refractories 38*a*. This results from the fact that the groove 46 may be shifted upwardly or

downwardly 1/16 inch relative to the ring 45 depending upon which of the end walls 47 or 48 of refractory 38*a* is placed in abutment with the refractories 38*b* disposed thereabove. In this manner, variations in the lengths of the refractories 38 due to normal manufacturing tolerances can be compensated by positioning the groove 46 so that its distance below the next higher course of refractories is either the dimension A or B depending on whether the aggregate length of the refractories thereabove is slightly longer or shorter than their nominal lengths.

It will be understood that the phrase "predetermined greater value" or "predetermined greater distance" as used herein and in the appended claims means a value in excess of that which would occur as a result of normal manufacturing tolerances.

As seen in FIG. 2, an aperture 54 is formed in the lower end of the refractory lining 16 of the vessel 10 and similarly in the steel shell 15 for connection to the bore 21 of the nozzle 20. This aperture is defined by a course of refractories 55 having a curved surface which terminates at one end from the floor of chamber 19 and at its other in the bore 21 of nozzle 20. Immediately below the course of refractories 55 is a course of refractories 38*c* in the upper end of the nozzle lining 38 and which has a notch formed in the lower end of its inside surface facing the bore 21. This notch is formed by a first horizontal surface 56 intersecting each refrectory's inside face and a second intersecting surface 57 which flares outwardly and downwardly relative to the axis of the bore 21. The next lower course of refractories 38*d* in the nozzle lining 38 is formed with intersecting surfaces 58 and 59 which are complementary to the surfaces 56 and 57 respectively of the refractories 38*c*. This provides a male portion on the upper end of the refractories 38*d* for mating with the notch in the refractories 38*c* so that a lap-butt joint is created therebetween which also coincides with the juncture of the nozzle 20 in the vessel 10.

The nozzle 20 is provided with a flange 60 surrounding its upper end for attachment to the vessel 10. A truncated metallic cylindrical section 61 extends downwardly from metallic shell 15 and surrounds the aperture 54. It can be seen that when the nozzle 20 is positioned below the vessel 10 a gap exists between the shell 37 of the nozzle and the cylindrical section 61 of vessel 10. This gap is filled by a high alumina ram mix 62 and a ring 64 is then secured to the upper end of the flange 60 and to the lower edge of the outer surface of the cylinder 61. It can be seen that at the junction between the vessel 10 and the nozzle 20 a weak spot is created due to the gap between the steel shells 15 and 37. For this reason, the lap-butt joint is employed between the lining 38 of nozzle 20 and the lining 16 of the vessel 10.

While only a single embodiment of the instant invention has been shown and described, and while the invention has been illustrated and discussed in relation to a particular vacuum degassing apparatus, it is not intended that the invention be limited thereby but only by the scope of the appended claims.

We claim:

1. A high alumina refractory for use in the inlet nozzle of a vacuum degassing vessel, said refractory being a hexahedron with four rectangular side surfaces and a pair of parallel trapezoidal end surfaces, one pair of said side surfaces being parallel and the other pair being non-parallel, one of said parallel side surfaces being wider than the other and having a transversely extending groove parallel to said end surfaces and intersecting each of said non-parallel side surfaces, said groove being symmetrical in cross-section and disposed a predetermined greater distance from one of said end surfaces than the other.

2. In a vacuum degassing vessel including a metallic nozzle extending from its lower end for drawing molten metal into said vessel for degasification and having lining

support means at its lower end and extending inwardly toward the axis of said nozzle, the improvement comprising a refractory lining for said nozzle including a plurality of refractories arranged in courses surrounding the longitudinal axis of said nozzle, each of the refractories defining the lowermost of said courses lying in side-by-side abutment and each having a transverse groove extending across one side and between a pair of longitudinal edges, each of said grooves embracing said lining support means to support the refractories thereabove in said lining, each of said grooves being located a predetermined greater distance from one of the ends of said refractories than the other, said grooves being symmetrical in cross-section so that said lining support means may be embracingly engaged with either of the ends of said refractories being in an upright position, whereby variations in the lengths of the refractories in said nozzle lining resulting from normal manufacturing tolerances may be compensated by reversing the refractories in said lowermost course.

3. In a metal encased refractory lined vacuum degassing vessel of the type having a metallic nozzle extending from its lower end and means for producing relative movement between said vessel and a ladle of molten metal disposed therebelow so that a decrease in the relative distance therebetween will draw molten metal through said nozzle and into said chamber for degasification, the improvement comprising a refractory lining for said nozzle including a plurality of courses of refractories, a metallic ring affixed to the lower end of said nozzle in a plane substantially perpendicular to its longitudinal axis, each of the refractories defining the lower course of said nozzle lining having a symmetrical in cross-section groove intermediate its ends and embracing the inner edge of said metallic ring to support the refractories thereabove in said nozzle lining, said groove being located a predetermined greater distance from one of its axial sides than the other, whereby variations in the lengths of the refractories in said nozzle lining resulting from normal manufacturing tolerances may be compensated by reversing the refractories in said lowermost course.

4. In a vacuum degassing vessel including a metallic nozzle extending from its lower end for drawing molten metal into said vessel for degasification and having lining support means at its lower end and extending inwardly toward the axis of said nozzle to terminate in an inner rim, the improvement comprising a refractory lining for said nozzle including a plurality of refractories arranged in courses surrounding the longitudinal axis of said nozzle, each of the refractories defining the lowermost of said courses being a hexahedron with four rectangular side walls and a pair of parallel trapezoidal end walls, one pair of said side walls being parallel and the other being non-parallel, one of said parallel side walls being wider than the other and having a transversely extending symmetrical in cross-section groove parallel to said end walls and intersecting said non-parallel end walls, the non-parallel sidewalls of adjacent refractories being in abutment, each of said grooves embracing said rim to support the refractories thereabove in said lining, each of said grooves being located a predetermined greater distance from one of the ends of said refractories than the other, whereby variations in the lengths of the refractories in said nozzle lining resulting from normal manufacturing tolerances may be compensated by reversing the refractories in said lowermost course.

5. In a metal encased refractory lined vacuum degassing vessel of the type having a metallic nozzle detachably connected to an aperture in the lower end of the vessel and extending downwardly therefrom, said nozzle

having an axial bore opening into said chamber through said aperture so that molten metal may be drawn through said nozzle and into said chamber for degasification, the improvement comprising a refractory lining for said nozzle and the aperture in said vessel and including a plurality of refractories arranged in courses surrounding said bore and said aperture, a first one of said courses being affixed to said vessel for defining the lower end of said aperture, a second one of said courses being disposed immediately below said first course and defining the upper end of said nozzle bore, a notch formed in the lower inside edge of each of the refractories in said first course to define a continuous groove in said aperture, the upper end of each of the refractories in said second course being formed to cooperatively engage said groove to provide therewith a lap-butt joint at the juncture of said nozzle and said aperture.

6. In a metal encased refractory lined vacuum degassing vessel of the type having a metallic nozzle detachably connected to an aperture in the lower end of the vessel and extending downwardly therefrom, said nozzle having an axial bore opening into said chamber through said aperture so that molten metal may be drawn through said nozzle and into said chamber for degasification, the improvement comprising a refractory lining for said nozzle and the aperture in said vessel and including a plurality of refractories arranged in courses surrounding said bore and said aperture, a first one of said courses being affixed to said vessel and defining the lower end of said aperture, a second one of said courses being disposed immediately below said first course and defining the upper end of said nozzle bore, a recess formed in the lower inside edge of each of the refractories in said first course by a pair of intersecting surfaces and disposed toward said bore to define a continuous groove in said aperture, a first one of said surfaces being substantially normal to the longitudinal axis of said more and intersecting the inner face of said refractory, said second surface extending downwardly and outwardly from said first surface, the upper end of each of the refractories in said second course being formed by a pair of surfaces complementary to the surfaces in the refractories defining said first course to cooperatively engage said groove and to provide therewith a continuous lap-butt joint at the juncture of said nozzle and said aperture.

References Cited by the Examiner

UNITED STATES PATENTS

167,831	9/75	Foster	50—436 XR
573,476	12/96	McCabe	50—436 XR
2,056,732	10/36	Mekler	50—157
2,125,192	7/38	Morlock	266—43
2,699,036	1/55	Nicholson	110—1 A
2,816,623	12/57	Wong	50—405 XR
2,906,521	9/59	Harders	266—34
3,006,046	10/61	Shephard et al.	266—43 XR
3,056,595	10/62	Knuppel	266—34

FOREIGN PATENTS

1,251,356	12/60	France.
734,184	4/43	Germany.

OTHER REFERENCES

Shamva Catalog No. 102, H. K. Porter Co. Inc., pages 10 and 13–15, received in U.S. Patent Office, January 2, 1958.

MORRIS O. WOLK, *Primary Examiner.*

RAY K. WINDHAM, *Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,203,688 August 31, 1965

Walter Sieckman et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 37, for "more" read -- bore --.

Signed and sealed this 22nd day of March 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents