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Zettlemoyer et al.

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[45] **May 29, 1973**

[54] **REPLACEABLE MOLTEN METAL NOZZLE STRUCTURE**

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[73] Assignee: **Milford A. Juten,** Washington, D.C. ; a part interest

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[21] Appl. No.: **124,186**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 802,138, Feb. 25, 1969, abandoned.

[52] **U.S. Cl.** **222/567,** 222/568, 222/569

[51] **Int. Cl.** **B22d 37/00**

[58] **Field of Search** .....222/DIG. 1, DIG. 23, 222/DIG. 20, 567, 568, 569

[56] **References Cited**

UNITED STATES PATENTS

3,502,249	3/1970	Wagstaff	222/DIG. 1
3,396,877	8/1968	Osterholtz et al.	222/DIG. 1
3,465,811	9/1969	Castelet	222/DIG. 1
3,354,939	11/1967	Calderon	222/DIG. 1
2,836,866	6/1958	McMillin	222/DIG. 1
1,072,972	9/1913	Michaels	222/DIG. 1
3,414,250	12/1968	Snow	222/DIG. 23
2,115,535	4/1938	O'Neil	222/DIG. 1

FOREIGN PATENTS OR APPLICATIONS

1,156,342	5/1958	France	222/DIG. 15

OTHER PUBLICATIONS

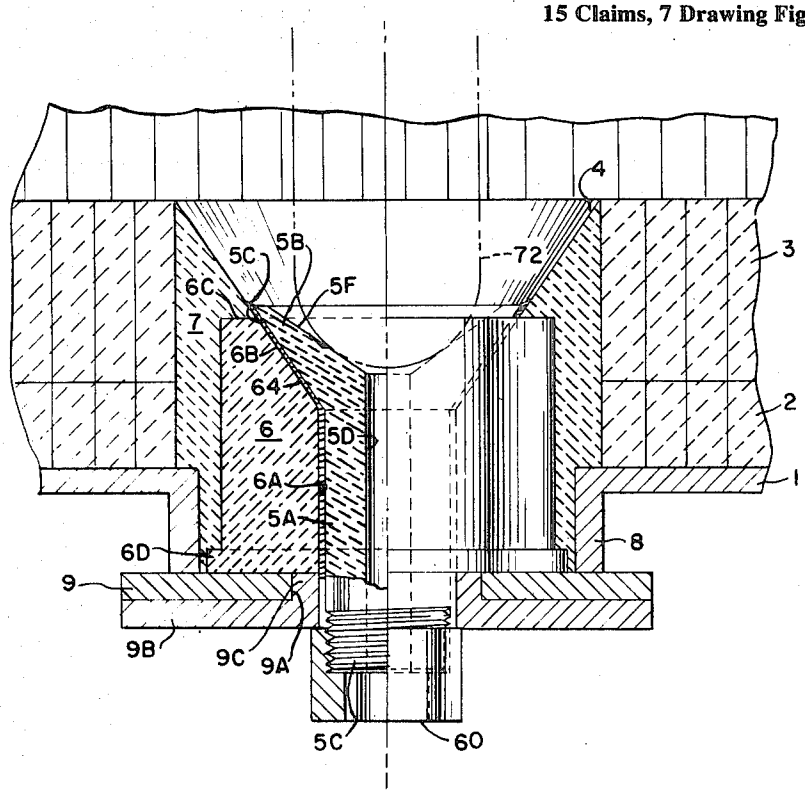
W. G. McDonough, "Nozzle Replacement from Outside is Safe and Efficient Method," April, 1954. Journal of Metals, pages 443–446.

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[57] **ABSTRACT**

A readily replaceable ceramic nozzle and well ring for use in ladles carrying molten metal to cooperate with a vertically moveable valve stop rod to control the flow of molten metal, the nozzle being of funnel-shape with the conical mouth providing a well ring and with the well ring and the tubular stem supported in a nozzle receiving block means of preformed ceramic material with the stem portion of the funnel extending through the block means to outside of the metal casing of the ladle, the stem having retaining means such as screw threads on its outer end cooperating with screw threads on a tubular nozzle extension with the tubular nozzle extension serving the dual function of retaining the nozzle in position and also preventing splattering of the molten metal. The nozzle receiving block means has a nozzle receiving opening conically enlarged at its upper end so that a minimum of fire clay mud seal is required to seal the funnel shaped nozzle in the nozzle receiving block means, the space between the rim of the block means and the fire brick lining of the ladle being filled with mortar-like material such as HELSPOT so that a minimum of moisture is used in the plastic sealing materials when replacing the nozzle whereby the nozzle can be used immediately instead of requiring the long waiting period for setting up and hardening of the plastic materials.

15 Claims, 7 Drawing Figures



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SHEET 1 OF 2

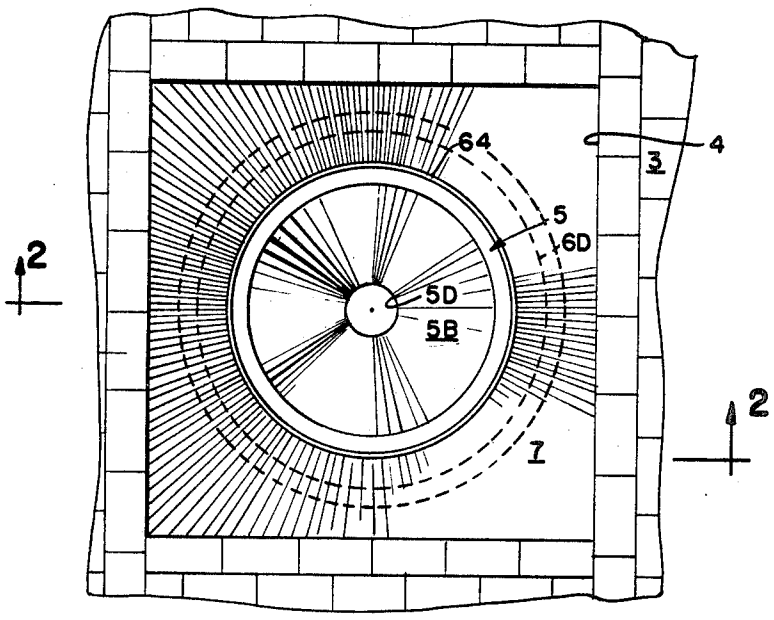


FIG. 1

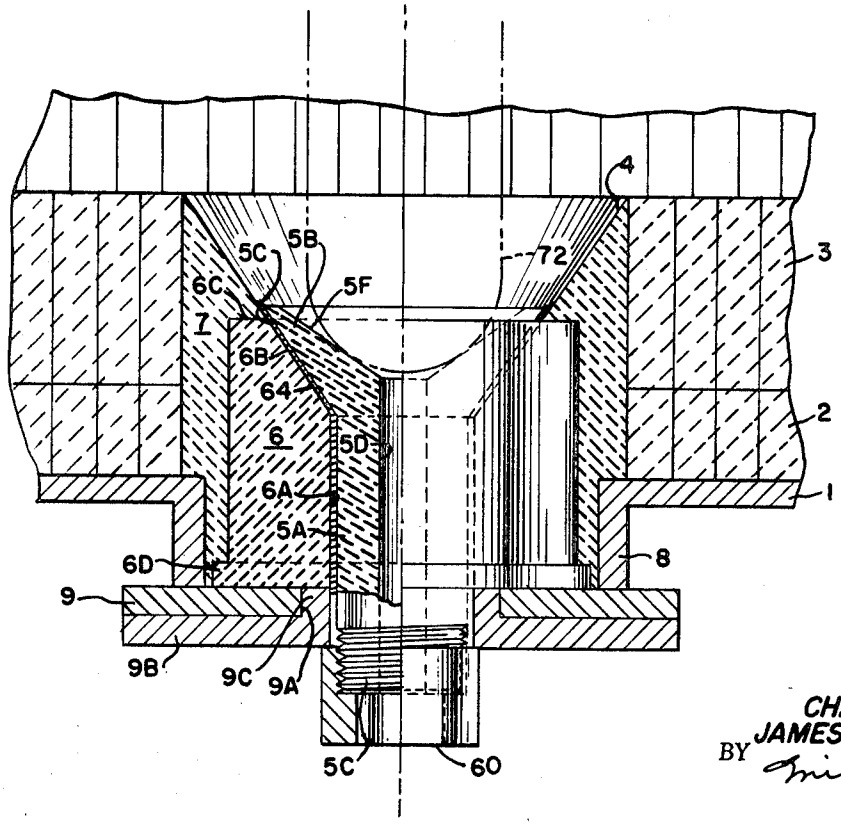


FIG. 2

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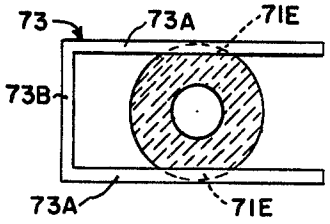


FIG. 6

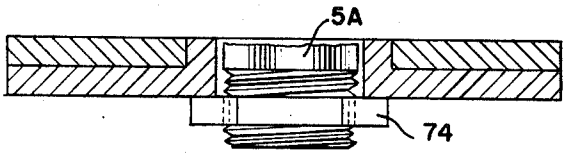


FIG. 7

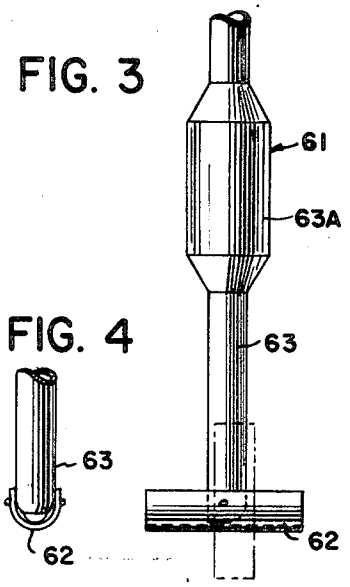


FIG. 3

FIG. 4

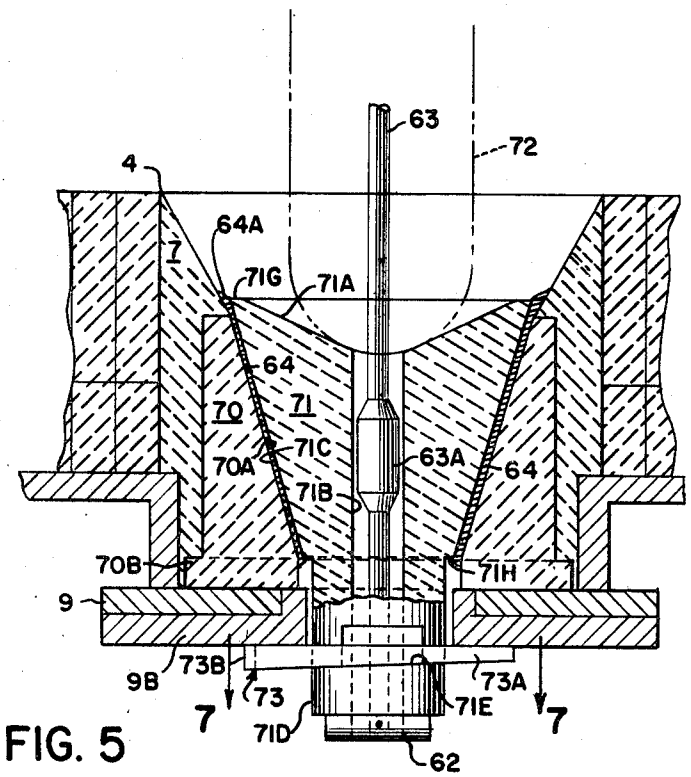


FIG. 5

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REPLACEABLE MOLTEN METAL NOZZLE STRUCTURE

The present invention is a continuation-in-part of the application of James E. Zettlemoyer Ser. No. 802,138; filed Feb. 25, 1969, now abandoned, for Nozzle and Well Ring and the subject matter thereof is incorporated herein by reference.

The present invention relates to handling molten metal and particularly to the replacement of nozzles for pouring the molten metal into large ingots and more particularly to the nozzle which penetrates through the fire brick bottom and the iron shell or casing of a pouring ladle.

Heretofore various types of nozzles have been used in the steel industry but the nozzles become eroded and have to be replaced and the time required for replacement of the nozzles of the prior art is excessive because of the large amounts of moisture laden plastic cement-like material used in forming the well ring or entrance to the nozzle since such cement-like material must set for a long time even when heat is applied because of the large amount of moisture in the large mass of cement-like material or mortar-like material which is used in properly positioning and forming the nozzle well or mouth.

An object of the present invention is to overcome the requirement for the use of a large amount of mortar-like material in positioning and fixing the ladle nozzle in operative position.

Another object is to provide an extension for the nozzle which serves to retain the nozzle in operative position and also serves to prevent splashing of the molten metal on the cold sides of the ingot mold thereby preventing scale on the ingot.

A further object is to provide positive nozzle retaining means.

Another object is to provide a method using a tool for inserting the nozzle so that a minimum of workman's time is required.

Other and further objects will be apparent as the description preceeds and upon reference to the accompanying drawings wherein:

FIG. 1 is a top plan view of the nozzle in the nozzle receiving block means and showing the upper surface of the mortar-like material sealing the block means in position.

FIG. 2 is a fragmentary vertical section taken substantially on line 2—2 of FIG. 1 with the nozzle shown mounted on a fragment of a ladle and showing the adjacent firebrick lining of the ladle and showing the nozzle splash preventing extension threaded onto a threaded extension of the nozzle stem.

FIG. 3 is a fragmentary elevation of the nozzle inserting tool with the pivoted T-head in its operative position on its tubular shaft and showing how such T-head can move to aligned position shown in dotted lines.

FIG. 4 is a fragmentary end view of the pivoted crosspiece in operative position.

FIG. 5 is a section similar to FIG. 2 showing another form of the invention with a U-shaped retaining wedge to maintain the nozzle in assembled relation.

FIG. 6 is a fragmentary section taken on line 6—6 of FIG. 5 showing the wedge used to retain the nozzle structure of FIG. 5.

FIG. 7 is a fragmentary section showing a cast iron nut retaining the threaded nozzle end.

Referring more specifically to the drawings, a fragment of a metal-pouring ladle has an outside metal casing cover 1 lined with a first layer of firebrick 2 forming the tank bottom and a second layer of firebrick 3 forming the second or inner tank bottom with the bricks being held together by suitable fireclay mortar-like material as is well known in the art with the firebrick arranged to leave an opening 4 receiving the nozzle assembly of a funnel-shaped nozzle 5, a nozzle receiving block 6, and mortar-like HELSPOT material 7. The nozzle receiving block 6 has a bore 6A having a conical enlargement 6B at its upper end which bore receives the hollow cylindrical stem 5A and the conical mouth or well ring 5B of the nozzle 5 the stem extending through the block 6 beyond the exterior of the casing 1. A rib 6D extends around the base of block 6 and serves to anchor the block in position in the mass of HELSPOT.

A tubular collar 8 is secured to the exterior casing 1 of the ladle by welding or the like and has a plate 9 secured thereto with the plate 9 having an aperture 9A through which the cylindrical stem 5A of the nozzle protrudes. A nozzle plate washer 9B having a tubular flange 9C is secured to the plate 9 by welding or the like. The free end of the nozzle stem 5A has external screw threads 5C and such screw threads cooperate with internal screw threads on a nozzle extension 60 which extension serves as a retaining nut against plate washer 9B to maintain the nozzle 5 in position and such extension 60 also serves to prevent splashing of the molten metal onto the sides of the ingot mold thereby avoiding scale on the ingots.

The funnel-shaped nozzle 5 includes the conical portion 5B flaring outwardly from the tubular stem 5A with the exterior periphery 5C of the conical portion 5B being received in the conical-shaped opening or enlargement 6B in the nozzle receiving block 6 which conical-shaped opening 6B merges with the aligned bore 6A through the nozzle receiving block 6.

The block 6 is axially aligned with washer 9 and is secured in position in the opening 4 of the fire brick lining by ramming the HELSPOT which is a mortar-like material which extends upwardly from the upper end 6C of the nozzle block 6 to the adjacent firebricks 3.

The nozzle 6 is made of well-known ceramic material such as firebrick and is inserted by means of a tool 61 shown in FIGS. 3, 4, and 5. The tool 61 has a pivoted crossbar 62 supported on an aluminum pipe 63 which carries a cylindrical spacer or stabilizer 63A of approximately the diameter of the bore 5D of the nozzle 5. A small amount of fireclay mud sealer 64 is plastered on the conical surfaces 5C and 6B and may be plastered along the bore in the block 6 and on the outer periphery of the stem 5A and the nozzle 5 is inserted into the block 6 from above as shown in FIG. 5. The screw threads 5C extending outwardly and the nozzle extension 60 is screwed on drawing the nozzle 5 tightly against the sealing fireclay mud seal 64 between the block 6 and the outer periphery of the nozzle and the tool 61 is removed.

From the above description the utility of the invention should be obvious. Initially the mortarlike HELSPOT 7 is used to fill the space and to seal the outer periphery of the block 6 within the opening 4 in the firebrick lining 2, 3 and the casing and tubular collar 8 and block supporting plate 9.

After a nozzle becomes useless because of the excessive erosion on its upper mouth surface **5F** it is necessary to replace such useless nozzle. The useless nozzle is pushed upwardly by a ram of suitable type after the threaded extension **60** is removed or the nozzle can be broken up and removed and a new nozzle inserted by merely cleaning away the hardened fireclay mud seal from surfaces **6A** and **6B** and applying a new coating of plastic fireclay mud seal **64** to the outer periphery of the new nozzle and inserting the new nozzle with the tool **61** as previously explained.

The method of insertion requires a minimum of workman time inside of the ladle and a minimum of "down time" of the ladle because the HELSPOT **7** remains practically intact and the small amount required to replace any damaged HELSPOT is kept to a minimum. The amount of fireclay mud seal is kept to a minimum by the close fit between the identical tapers of the conical portions so that any moisture therein can readily evaporate or set with a minimum of exposed surface so that the ladle can be put back into use in a minimum of time. The mud seal may be omitted between surfaces **6A** and the stem **5A** to permit expansion of the tubular stem **5A**.

Referring more particularly to FIG. **5** where similar parts are identified by the same reference numerals, a modified cylindrical nozzle receiving block **70** has a conical opening **70A** therethrough and having an outwardly extending flange **70B** and such nozzle receiving block is retained in position by the HELSPOT **7** which is shaped to provide a smooth continuation of the inner conical surface **70A** of the nozzle receiving block **70** so that a smooth surface is obtained to the inner surface of the firebrick lining **3** to thereby provide for a smooth movement of the molten metal.

The funnel-shaped nozzle **71** has a conical hollow upper surface **71A** which merges with a bore **71B** which extends completely through the nozzle **71** while the exterior of the nozzle has a conical surface **71C** merging into a cylindrical surface **71D** providing the stem of the funnel-shaped nozzle **71.** Fireclay mud seal **64** is applied to the mating conical surfaces **70A** and **71C** and the nozzle inserted with the tool **61** as previously described.

The cylindrical extension **71D** of the nozzle is provided with diametrically opposed grooves **71E** which taper from the left to the right as shown in FIG. **5** and a U-shaped wedge **73** having legs **73A**, **73A** and a connecting portion **73B** is used to retain the nozzle in an assembled condition by forcing the wedge in the grooves and thereby retain the nozzle in place.

It will be apparent that a mud seal **64** of a minimum of fireclay is used to seal the nozzle **71** in the nozzle receiving block **70** as explained above and the insertion of the nozzle is substantially the same as that described with respect to the first modification and the tools may be used in a similar manner.

A stopper rod **72** shown in phantom controls the flow of molten metal in a well-known manner.

It will be also apparent that the conventional nut such as a cast steel ring **74** may be used in the form of the invention having the threaded end **5C** at the free end of the nozzle to retain the nozzle in place and draw the nozzle to a sealed molten metal tight joint so that the ladle can be put back into use in a minimum of time. The mud seal may be omitted between surfaces **6A** and the stem **5A** to permit expansion of the tubular stem **5A**.

The present invention is particularly useful in handling molten steel in the basic method and referring to FIG. **5,** the plastic mud **64** is applied to the outer periphery of the conical portion **71C** of the nozzle and the nozzle inserted in place in the nozzle receiving block **70** by means of the tool **61** as previously explained. The cylindrical end **71D** of the nozzle extends through the washer **9B** and a pulling force thereon causes the nozzle to be properly seated and forces the fireclay mud **64** to make a complete seal around the periphery with the upper edge substantially flush with the flat upper portion **71G** of the nozzle producing a tight seal between the Helspot **7** and the outer periphery of the nozzle as shown at **64A.** And excess fireclay mud that rises thereabove produces a neat filet resulting in a smooth flow of the molten metal from the ladle into the nozzle and any erosion which occurs in the nozzle does not have any effect on the nozzle receiving block **70.** The upper surface **71A** of the nozzle provides a valve seat with the control rod **72** and when erosion becomes excessive the control rod will not stop the flow of metal and therefore it is necessary to replace the nozzle.

With the present invention it is a very simple matter to replace the nozzle by pushing the nozzle upwardly with a suitable ram or the like and the taper prevents damage to the nozzle receiving block and to the Helspot **7.** If any roughness does occur on the concave conical surface **70A** of the nozzle receiving block **70,** it can be cleaned off with a tool through the opening **9A.**

To assure that the correct seating occurs additional clearance is made by means of a notch **71H** to permit any excess fireclay mud to ooze downwardly and permit the nozzle to come to its final position.

It will also be noted that the flattened portion **71G** of the nozzle is substantially above the top edge of the nozzle receiving block and the Helspot **7** prevents any contact of the molten metal with the nozzle receiving block **70** and therefore the nozzle receiving block **70** will last for a very large number of replacements of the nozzle **71.**

It will also be apparent that the fireclay mud which extends between the top of the nozzle and the Helspot **7** will come directly in contact with the molten steel and upon contact therewith immediately crystallizes so that even though the fireclay mud may not be fully set, the ladle may be used without delay resulting in full use of the ladles with a minimum of "down time."

It will be apparent that changes can be made within the spirit of the invention as defined by the valid scope of the claims.

What is claimed is:

1. A readily replaceable nozzle structure for pouring molten metal from a brick lined pouring ladle comprising nozzle receiving block means of preformed refractory material having a bore therethrough with the upper end of said bore of said block means having a conically upwardly diverging mouth, a replaceable nozzle of preformed refractory material having a bore therethrough and a conically upwardly diverging well portion opening upwardly therefrom, said nozzle having an exterior corresponding to the said conically upwardly diverging mouth opening to said nozzle receiving block, said nozzle having a stem portion of sufficient length to project through said pouring ladle, said

exterior of said nozzle being closely positioned with respect to said bore through said nozzle receiving bore of said block means whereby a minimum of fireclay mud is required to seal the space between said nozzle and said nozzle receiving block means requiring a minimum of replacement time, said block means being covered by mortar-like material whereby said block means may be positioned within said brick lining of said ladle and secured in place in said lining with said mortar-like material, said nozzle being coated on its exterior with fireclay mud and said nozzle inserted from above through said bore of said nozzle receiving block means and said nozzle pressed into position causing said fireclay mud to ooze out between said nozzle and said block means thereby sealing the joint between said nozzle and said nozzle receiving block means, and said nozzle and said mortar-like material completely covers said upper end of said block means and extends to said brick lining thereby protecting said block means and extends to said brick lining thereby protecting said block means from contact with said molten metal whereby metal will not contact said block and said nozzle may be replaced many times without requiring replacement of said block means

2. The invention according to claim 1 in which the tubular stem section of the nozzle is provided with fastening means at its end opposite the conically diverging mouth to be secured outside of the ladle.

3. The invention according to claim 2 in which the fastening means on the tubular stem includes screw threads and a tubular nozzle extension having cooperating screw threads adapted to be screwed into the threads of the tubular stem of the nozzle with the bore of the extension in alignment with the bore of the nozzle.

4. The invention according to claim 2 in which the mouth of the nozzle is above the top of the nozzle receiving block and the fastening means includes a U-shaped wedge and the tubular stem section is provided with grooves to receive the legs of the wedge to draw the nozzle into position and thereby force said fireclay and mud providing sealing plastic material over the upper edge of said nozzle preventing molten metal from contacting said block means, the sealing plastic oozing out from the upper edge of the nozzle completely sealing said nozzle receiving block from molten metal whereby many nozzles may be replaced in a single nozzle receiving block.

5. The invention according to claim 1 in which the nozzle projects outwardly of the ladle exterior and means are applied to the portion of the nozzle exterior of the ladle to urge the nozzle to operative position and cause the mud seal to ooze out from the joint between the exterior of the nozzle and the upwardly opening conical bore portion of the block.

6. The invention according to claim 5 in which the means to secure the nozzle is a U-shaped wedge and the portion of the nozzle exterior to the ladle has grooves for receiving the U-shaped wedge to press the nozzle into effective contact with fireclay mud seal to provide an effective seal between said nozzle and said block means and Hellspot is shaped above said fireclay mud seal overlies a portion thereof, said nozzle being of a height above the top of said block means when said nozzle is in its operative position.

7. The invention according to claim 1 in which the top of the nozzle extends above the top of the block means.

8. The invention according to claim 1 in which said nozzle includes a tubular stem extending below said block means and said nozzle and block means are mounted in a ladle having a fire brick lining with a minimum of mortarlike material between said fire brick and said block means and a minimum of fire clay mud seal between said block means and said nozzle.

9. The invention according to claim 1 in which the block means includes a collar flange of larger transverse dimension than the transverse dimension of the block means.

10. A nozzle structure according to claim 1 in which the block means includes a portion of large radial dimension and a nozzle well receiving body of smaller radial dimension, said nozzle receiving block being of approximately the maximum radial dimension of the nozzle mouth whereby erosion by pouring metal occurs in the well ring of the nozzle.

11. A method of installing and replacing nozzles in a ladle for molten metal comprising securing a nozzle receiving block means of preformed refractory material having a bore therethrough with the upper end of said bore having a conically upwardly diverging mouth into a nozzle receiving opening of a ladle lining and forming a smooth contour from said nozzle receiving block means to said lining of said ladle with a mortar-like settable plastic material thereby securing said block means permanently in position, inserting a replaceable nozzle of preformed refractory material, said nozzle having a bore therethrough and a conically upwardly diverging well portion opening upwardly thereform, said nozzle having an exterior corresponding to the said conically upwardly diverging mouth opening of said nozzle receiving block means, applying plastic sealing material such as fireclay mud seal to the contacting surfaces of said nozzle and said nozzle receiving block and thereafter inserting said nozzle so the lower stem end thereof projects near the outer surface of said ladle and applying a force to said nozzle to assure proper sealing contact between the outer periphery of said nozzle and said bore through said nozzle receiving block which receives said nozzle, and thereafter applying mortar like material between said nozzle, and said nozzle receiving block means to completely cover said nozzle receiving block means and smoothly merging with said ladle lining whereby said molten metal does not contact the block means and said nozzle may be replaced many times.

12. The invention according to claim 11 in which said nozzle includes said stem which is projected beyond the exterior of said ladle and a fastening means is applied to said stem to urge and secure said nozzle in position.

13. The invention according to claim 11 in which the nozzle is supported on a long rod extending downwardly from the upper open end of the ladle to completely eliminate the time required for a workman to be within the ladle.

14. The method according to claim 11 in which the nozzle receiving block has a funnel-shaped bore therethrough, and the nozzle is of funnel shape corresponding to the funnel-shaped bore with the conical mouth of the nozzle forming the well ring, the plastic fireclay mud seal being applied in a thin layer between the outer surface of the well ring and the conical mouth of

the funnel-shaped bore whereby a minimum of plastic seal effectively seals the nozzle, the nozzle being movable into sealing position by force applied to the lower end of the nozzle, whereby the nozzle can be replaced in a minimum of time.

15. The invention according to claim **11** in which said preformed ceramic block has a substantially conical bore therethrough extending substantially the length thereof and said removable nozzle has a corresponding exterior periphery and a projection of sufficient length to extend outside of said ladle and such projection includes a groove on each side thereof and a U-shaped wedge element is passed into said grooves to effectively urge said nozzle downwardly into final position, the upper end of said nozzle extending above the preformed ceramic block and the settable plastic completely covers the inwardly exposed portions of the ceramic bloc means so that an old used nozzle may be readily removed by removing the wedge and forcing the old nozzle upwardly without damaging said block means and a new nozzle may be inserted from above without requiring a substantial time of a workman within the ladle.

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