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Boto

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[54] **APPARATUS FOR FORMING A REFRACTORY NOZZLE BODY**

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[73] Assignee: **United States Steel Corporation,** Pittsburgh, Pa.

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Related U.S. Application Data

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[52] **U.S. Cl.** **249/142,** 249/83, 249/146, 264/30

[51] **Int. Cl.** **B28b 7/18**

[58] **Field of Search** 249/83, 84, 85, 92, 126, 249/128, 129, 139, 146, 186, 184, 177, 149, 155, 163, 165, 171, 90, 91, 96, 97, 176; 264/30, 269; 266/42

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[57] **ABSTRACT**

An apparatus for forming a refractory nozzle body in a vessel, such as a tundish from which liquid metal is teemed into a continuous-casting mold. The apparatus comprises a plurality of forming sections, which together are contoured to define a nozzle well. The sections are installed one at a time in an opening in the refractory lining of the vessel. As each section is installed, a layer of plastic refractory is rammed thereabout.

6 Claims, 3 Drawing Figures

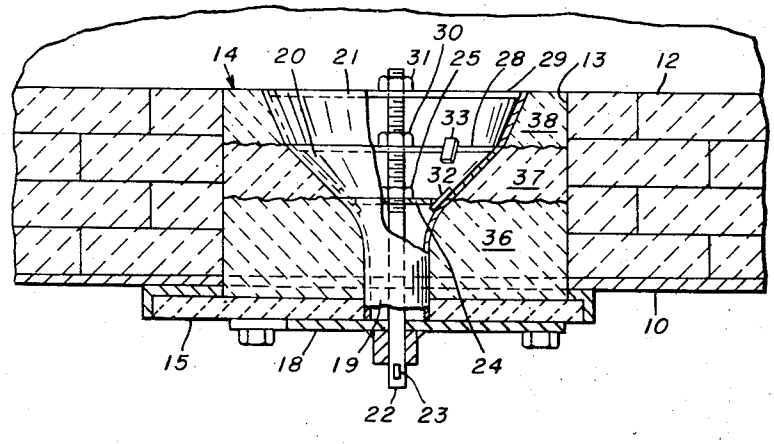


FIG. 1.

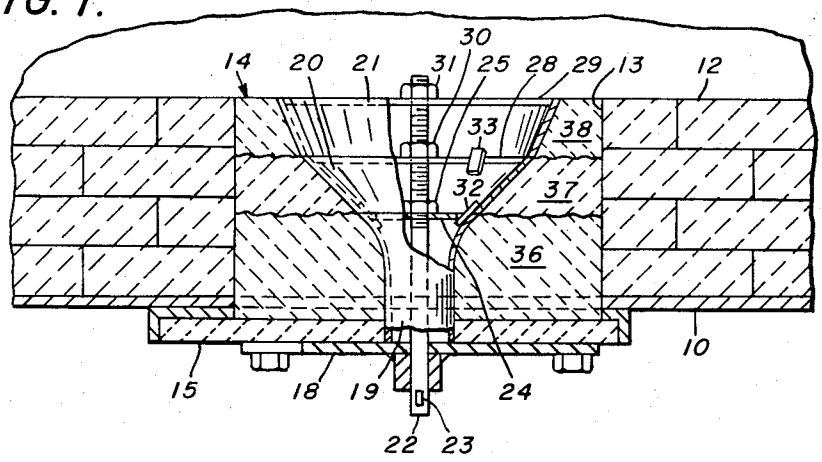


FIG. 2.

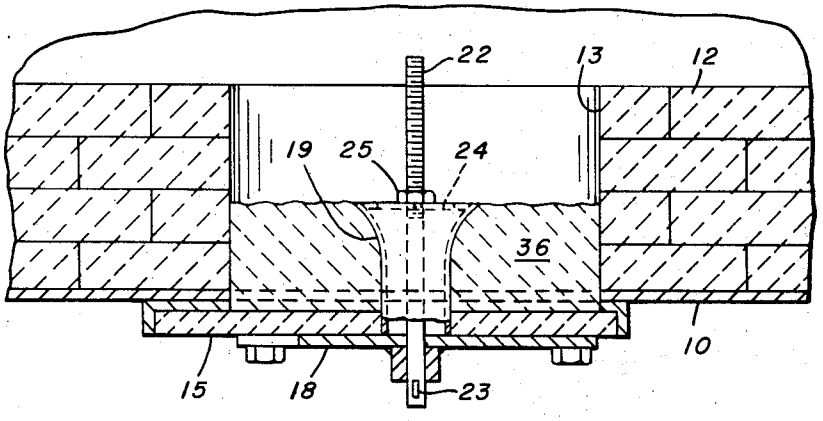
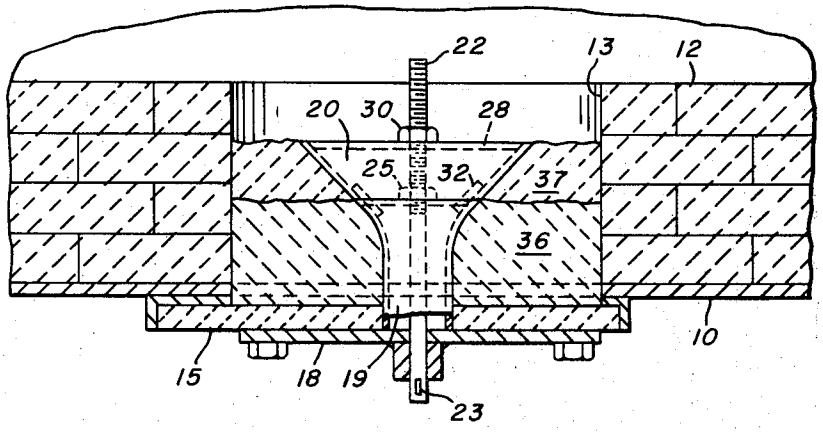


FIG. 3.



APPARATUS FOR FORMING A REFRACTORY NOZZLE BODY

This is a division, of application Ser. No. 173,438, filed Aug. 20, 1971.

This invention relates to an improved apparatus for forming a refractory nozzle body in a vessel.

Although my invention is not thus limited, my apparatus is particularly useful for forming the nozzle in the bottom wall of a tundish from which liquid metal is teemed into a continuous-casting mold. A conventional tundish has a metal shell and a lining of refractory brickwork. At the bottom wall the brickwork has one or more openings in which plastic refractory is rammed to form a corresponding number of nozzles. The refractory body of a nozzle wears rapidly and requires frequent replacement. Heretofore the practice has been to ram refractory around wooden plugs inserted in the opening in the brickwork, after which a mason would cut the refractory to form a properly contoured nozzle well. This practice not only is time-consuming, but produces a short-lived nozzle, since the refractory usually is not compacted properly.

An object of my invention is to provide an improved nozzle-forming apparatus which expedites the operation and also produce a more densely compacted nozzle body.

A further object is to provide a nozzle-forming apparatus which comprises a plurality of sections, each contoured to enable a layer of refractory to be rammed around it, the fully assembled apparatus being contoured to define the complete nozzle well.

In the drawing:

FIG. 1 is a vertical sectional view through the nozzle of a tundish in which my fully assembled apparatus is installed at the finish of a forming operation, the apparatus being partially broken away;

FIG. 2 is a vertical sectional view similar to Figure 1 but showing an earlier step in the forming operation; and

FIG. 3 is another similar view but showing a step subsequent to FIG. 2.

The drawing shows a portion of a conventional tundish, which includes a metal shell **10** and a lining **12** of refractory brickwork. The brickwork of the bottom wall has one or more openings **13** in which plastic refractory is rammed to form a nozzle **14.** Usually a tundish of this type is equipped with a slidable gate mechanism supported below the nozzle to control discharge of metal through the nozzle. The gate mechanism includes an orifice plate **15** affixed to the underside of the bottom wall. I have not shown other parts of the gate mechanism, since they are not involved in my invention and are taken off to permit my forming apparatus to be installed. Reference can be made to Shapland U.S. PAT. No. 3,352,465 for a showing of a complete slidable gate mechanism.

The forming apparatus of my invention includes a base plate **18,** which I bolt to the underside of the orifice plate **15** after removing the rest of the gate mechanism. Conveniently the base plate has bolt holes which correspond with the bolt holes in the orifice plate used to attach said mechanism. In my fully assembled apparatus shown in Figure **1,** a lower forming section **19** overlies the base plate **18,** a middle forming section **20** overlies the lower section, and a top forming section **21** overlies the middle section. Each section is hollow and its side walls are fabricated of sheet metal. The three

sections together define the contours of the nozzle well.

I removably connect a threaded rod **22** to the base plate **18,** as with a key **23** inserted through a transverse slot in the rod beneath the base plate. The rod extends upwardly from the base plate through the three forming sections **19, 20** and **21.** The lower section **19** has a cover plate **24,** to the upper face of which I weld a nut **25.** Rod **22** threadedly engages this nut. The middle and top sections **20** and **21** have straps **28** and **29** respectively extending across their upper edges. Removable nuts **30** and **31** are threadedly engaged with rod **22** and bear against straps **28** and **29** respectively to hold the middle and upper sections in place. The middle and upper sections have prongs **32** and **33** respectively extending downwardly and inwardly from their lower edges. Prongs **32** fit within corresponding slots in the cover plate **24.** Prongs **33** fit within the open top against the inner face of the side wall of the middle section **20.** Thus the prongs facilitate aligning the three sections.

According to my forming method, I install the base plate **18** on the orifice plate **15,** as already explained. I assemble the lower forming section **19** and rod **22,** and install the section and rod on the base plate within the opening **13** in the brickwork **12.** I insert key **23** through the slot in the low portion of the rod. Next I ram a lower layer **36** of plastic refractory within the opening **13** around the lower section **19,** as FIG. **2** shows. The space within the opening **13** is easily accessible, whereby I can properly compact the refractory. Next I install the middle forming section **20** and nut **30** on the rod and ram a middle layer **37** of refractory over the lower layer **36,** as FIG. **3** shows. Finally, I install the top forming section **21** and nut **31** on the rod and ram an upper layer **38** of refractory over the middle layer **37.** Thereafter, I remove the three forming sections **19, 20** and **21** and rod **22** from above and the base plate **18** from below, leaving the completed nozzle body **14** in place.

The nozzle well is accurately contoured to the shape of the assembled forming sections. The plastic refractory of each layer is firmly compacted to maximum density. An unskilled laborer can perform the entire nozzle-forming operation in as little as about three hours. Thus my invention not only expedites the nozzle-forming operation and makes it unnecessary to utilize skilled labor, but also produces a nozzle of longer life. While I have shown a three-section forming apparatus, it is apparent the apparatus could have a different number of sections.

I claim:

1. An apparatus for use in forming a refractory nozzle body in a vessel which has a refractory lining with an opening for the nozzle body, said apparatus comprising a base plate, means for fixing said base plate to the exterior of the vessel at the opening, a first forming section overlying said base plate to be positioned in the portion of the opening adjacent the exterior of the vessel, an additional forming section overlying said first section to be positioned in the portion of the opening adjacent the first-named portion, a rod connected to said base plate and extending through said sections, and means removably connecting each of said sections to said rod, the outer surfaces of said sections defining the contours of portions of a nozzle well, said outer surfaces being spaced from the lining surface when the sections are positioned in the opening to enable succes-

sive layers of plastic refractory to be rammed in the opening around each section in turn as the section is connected to said rod and positioned in the opening.

2. An apparatus as defined in claim 1 in which said rod is threaded, and the means connecting said sections to said rod includes respective nuts engaging said rod over each section.

3. An apparatus as defined in claim 2 in which the nut over said first section is welded to this section and the other nuts are removable with respect to their sections.

4. An apparatus as defined in claim 2 in which said sections have sheet metal side walls and the sections other than the first have prongs received in the adjacent section.

5. An apparatus as defined in claim 2 in which said rod has a key and slot connection with said base plate.

6. An apparatus as defined in claim 2 in which there are three sections.

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