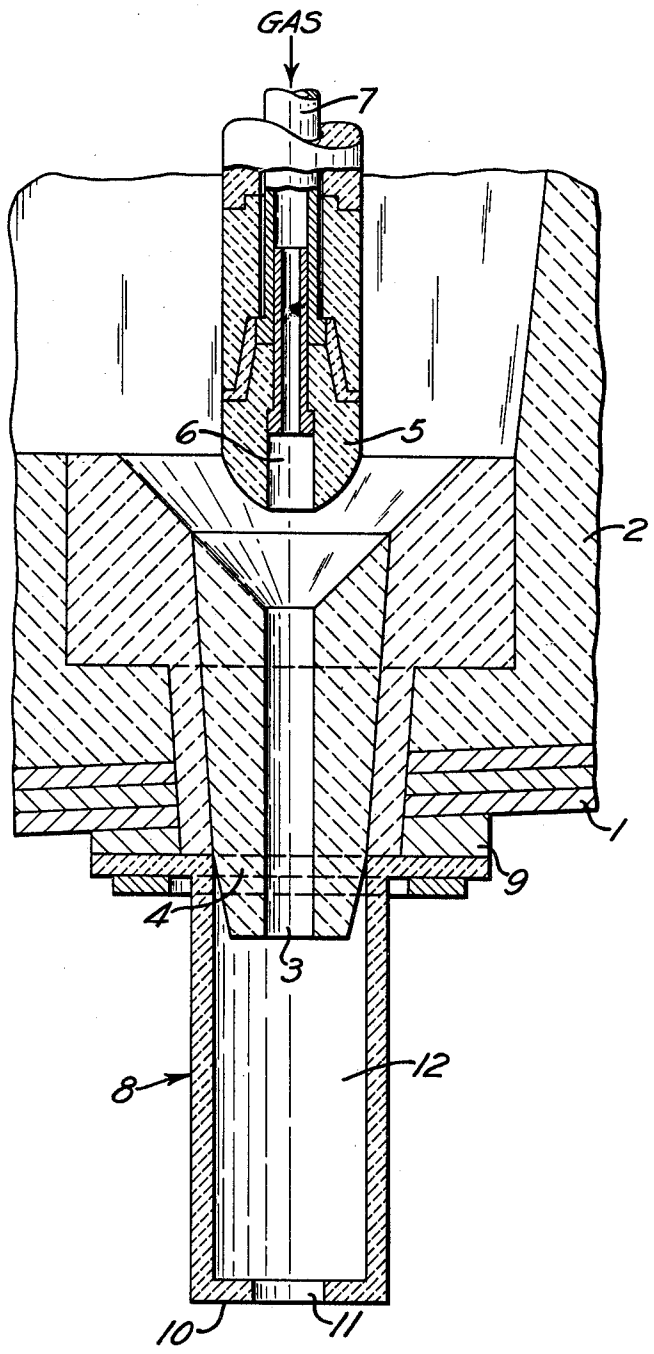
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EXPANSION-CHAMBER EXTENSION FOR
GAS-CONTROLLED TEEMING NOZZLE
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EXPANSION-CHAMBER EXTENSION FOR GAS-CONTROLLED TEEMING NOZZLE

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ABSTRACT OF THE DISCLOSURE

A refractory-lined expansion chamber mounted in a concentric and downwardly extending position with respect to a teeming nozzle in the bottom of a ladle for molten metal, said chamber forming an extension for the nozzle and providing space for thermal expansion of gas introduced into the metal to regulate the rate at which it teems through the nozzle, and for the dispersion of such gas in the metal.

This invention relates to teeming control apparatus of the type in which gas is introduced into molten metal in regulated amounts to control the rate at which it teems through the orifice of a ladle nozzle. As indicated, the invention relates, more particularly, to a teeming nozzle extension that forms a refractory-lined expansion chamber through which the gas and metal from the ladle nozzle gravitate, and which is constructed to provide for uniform dispersion of the gas in the metal and its thermal expansion.

The invention appertains, more specifically, to the method and apparatus for regulating the rate at which molten metal teems through a ladle nozzle, which is disclosed in my prior Patent No. 3,200,457, dated Aug. 17, 1965. As disclosed in this patent, the teeming rate may be controlled by introducing gas in regulated quantities into the metal teeming through the nozzle orifice. The practice of this method, however, presents a problem in that the temperature of the molten metal is usually substantially greater than that of the gas, which consequently expands as it passes with the metal through the nozzle. Since the gas is still expanding as it falls with the metal stream, it tends to blow the stream apart and causes serious splashing.

This invention, accordingly, has as one of its principal objects the provision of an apparatus which will eliminate the effects of expanding gas on molten metal teeming through a ladle nozzle with respect to breaking up the streamline flow of the metal and the consequent splashing in the manner described above. To this end, the invention contemplates the nozzle extension mentioned above, which provides for expansion and dispersion of the gas in the metal teeming therethrough, so that the gravitational flow of metal from the expansion chamber may be continued without fragmentation of the stream or splashing of the metal.

Other objects and advantages of the invention will become apparent from the following description, and the accompanying drawing, in which the single figure is a fragmentary vertical sectional view of a ladle showing somewhat diagrammatically the structure of the expansion chamber of this invention and the manner in which it is applied to a gas-controlled teeming nozzle.

The drawing shows a ladle for molten iron or steel which comprises a steel shell 1 having a lining 2 of firebrick, or other refractory material. A vertically extending teeming orifice 3 is provided in the bottom of the ladle

by a nozzle 4 of fire clay or other suitable refractory material, which is normally closed by a stopper head 5 of fire clay or graphite. The stopper head 5 forms part of a stopper rod assembly that has a conventional mounting and operating mechanism for effecting its movement vertically between opened and closed positions.

As shown and described in greater detail in my above-mentioned patent, the stopper head 5 has a axially extending opening 6 through which gas is fed by the tube 7 from a suitable source as indicated by the arrow. When the stopper rod assembly is lowered to engage the stopper head 5 with the upper end of the nozzle 4 and close it against teeming movement of the metal through the orifice 3, gas may be circulated through the opening 6 and orifice 3 for cooling purposes as disclosed in Belding Patent No. 2,005,311. In the open position of the stopper head 5 shown in the drawing, gas delivered through the tube 7 under the control of a throttle valve (not shown) is carried through the nozzle orifice 3 with the metal teeming therethrough, and operates to limit the quantity of metal that will teem through the nozzle in a given period of time, the rate at which the metal will teem through the nozzle being reduced as the gas flow through the opening 6 is increased.

The structure of the ladle and stopper rod thus far described is disclosed in the patents mentioned above and, accordingly, forms no part per se of this invention. The objects of this invention with respect to minimizing splashing of molten metal teeming through the nozzle orifice 3 are effected by an expansion chamber shown diagrammatically in the drawings in the form of a refractory cylinder 8 which extends downwardly from the bottom of the ladle and is arranged concentrically with respect to the nozzle orifice 3. The cylinder 8 has a gas-tight connection at its upper end with a nozzle-ring 9 secured to the bottom of the ladle, and a ring 10 at its lower end which defines an orifice 11 through which the mixture of gas and metal received from the nozzle 4 is discharged. The cylinder 8 has a diameter which as shown in the drawing is at least twice the diameter of the orifice 3, and an axial length which is at least equal to that of the orifice 3, so that the volume of the chamber 12 defined by the cylinder 8 is several times that of the orifice 3. In addition the discharge orifice 11 has a diameter, which, for example, and as shown in the drawing, is slightly larger than that of the orifice 3, so that the chamber 12 becomes filled with mixed gas and metal during teeming operation of the nozzle 4. By reason of its relatively larger volume compared to that of the orifice 3, the chamber 12 enables heating of the gas to temperature of the metal before discharge from the orifice 11. In this manner, the chamber 12 provides for thermal expansion of the gas and its dispersion in the metal in the form of small bubbles during teeming movement therethrough. Since the thermal expansion of the gas is substantially complete upon discharge from the orifice 11, it will be apparent that the gas is thereafter ineffective to disturb the teeming flow of metal downwardly from the orifice 11. In addition, the gas in the metal enables collection of the metal in an ingot mold with a minimum of splashing.

I claim:

1. In a teeming control apparatus for a molten metal ladle, the combination with a teeming nozzle having an axially extending orifice and means for introducing gas into the metal teeming through said nozzle orifice to regulate the rate at which metal teems from said ladle, of a refractory cylinder arranged concentrically with respect to and extending downwardly from said nozzle, said

cylinder having a gas-tight connection at its upper end with the bottom of said ladle and a refractory ring at its lower end defining a central opening for the discharge of mixed gas and metal from said cylinder, said cylinder having a length at least as long as the length of said orifice and a diameter of about twice the diameter of said orifice, said discharge opening in said ring having a diameter smaller than that of said cylinder and slightly larger than the diameter of said nozzle orifice and thus having a size such that the gas and metal from said orifice fill said cylinder during a teeming operation of said nozzle and the interior of said cylinder acts as an expansion chamber which provides for thermal expansion and dispersion of the gas in the metal during downward flow from said nozzle to said discharge opening.

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222—510, 566; 239—601