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NOZZLE FOR TEEMING VESSEL

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FIG. 1.

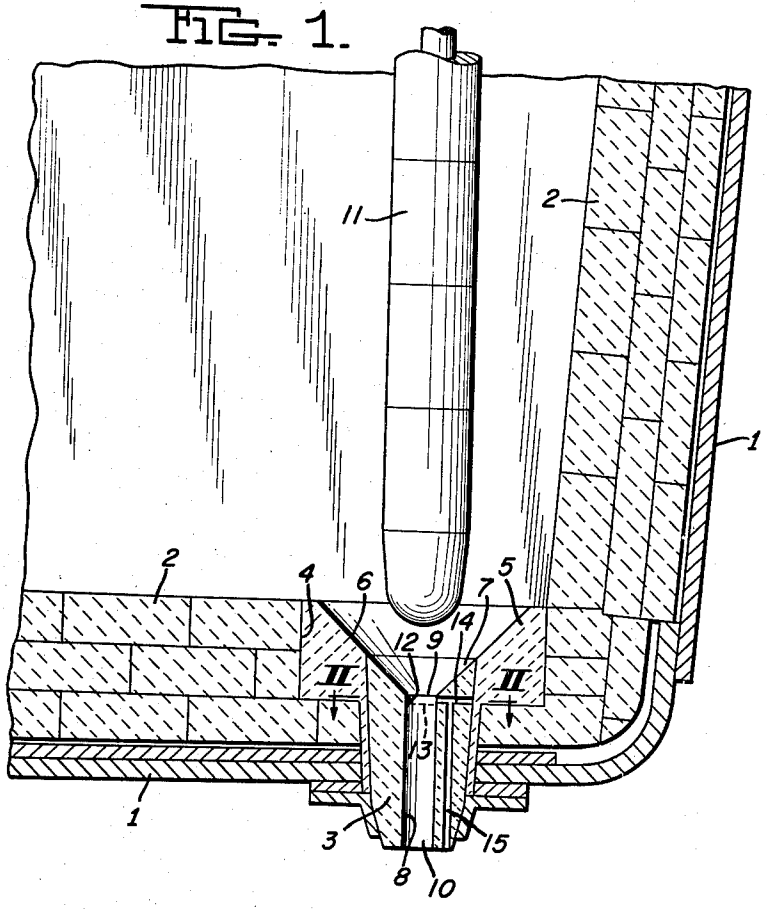
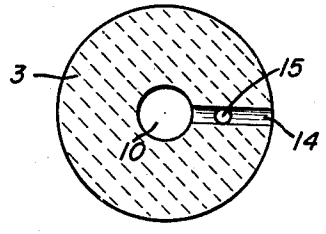


FIG. 2.



INVENTORS:
EARLE A. NIRMAIER and
JAMES B. WAGSTAFF,

BY: Donald G. Dalton

their Attorney.

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NOZZLE FOR TEEMING VESSEL

Earle A. Nirmaier, Maplewood, and James B. Wagstaff, Ridgewood, N. J., assignors to United States Steel Corporation, a corporation of New Jersey

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3 Claims. (Cl. 22—85)

This invention relates to a nozzle having improvements directed to the end of streamlining the flow of fluid therethrough and, more particularly, to a teeming nozzle for streamlining the flow of molten metal from a refractory lined metal ladle into an ingot mold.

In the casting of metal ingots, splashing of molten metal being teemed into a mold causes ingot surface defects, the more common of which are scabs, folds and non-metallic inclusions. The molten metal is of course teemed into the ingot mold through a teeming orifice extending vertically and centrally of a nozzle mounted in the bottom of a ladle. In order to reduce splashing and the resulting ingot surface defects, it is desirable to have the metal flow from the nozzle orifice with as little turbulence and spraying as possible. For this purpose, the conventional practice has been to construct teeming nozzles with a length several times the orifice diameter in order to obtain a streamline flow of the teeming metal. However, this practice has not proved entirely effective and the problem of splashing in the casting of metal ingots continues to be troublesome.

One of the principal objects of the invention is to provide an improved teeming nozzle which will be effective under different pouring conditions to streamline the flow of metal from the ladle into an ingot mold.

Another object of the invention is to eliminate cavitation of a stream of metal during teeming movement through a teeming nozzle orifice.

A further object of the invention is to provide a teeming nozzle for metal ladles with a passageway for venting its orifice to the atmosphere or other suitable gaseous medium.

A still further object of the invention is to provide a vented nozzle of the character just referred to in which the venting passageway opens into the nozzle orifice at a point adjacent the intersection of the conical well and cylindrical bore which cooperate to form the nozzle orifice. In the preferred embodiment of the invention, the venting passageway opens in a manner to be described into the nozzle orifice at the upper end of its cylindrical bore and just below its intersection with the conical well at the upper end of the nozzle.

Other objects and advantages of the invention will become apparent from the following description.

In the drawings, there is shown a preferred embodiment of the invention. In this showing:

Figure 1 is a fragmentary sectional view of a teeming ladle having a nozzle constructed in accordance with the principles of this invention; and

Figure 2 is an enlarged sectional view of the nozzle taken along the line II—II of Figure 1.

In the drawings, the numeral 1 designates the metal shell of a teeming ladle which has a lining 2 of refractory material. A teeming nozzle 3 comprising a refractory body is mounted at the bottom of the ladle in a position concentrically of aligned openings through the lining 2 and shell 1. The nozzle opening in the refractory 2 has a stepped configuration providing an enlargement 4

in which a rammed well 5 of refractory material is received to mount the nozzle in position. The well 5 has an upwardly facing conical recess 6 forming a continuation of the surface of a conical well or depression 7 in the upper end of the nozzle 3. The nozzle 3 has a centrally located cylindrical bore 8 which intersects with the conical well 7 and defines a circle 9 at its point of intersection therewith. The conical well 7 and cylindrical bore 8 depending therefrom cooperate to provide a teeming orifice 10 through the nozzle 3. A stopper rod 11 has seating engagement at its lower end against the conical well 7 for stopping the flow of metal through the orifice 10. The ladle construction thus far described is conventional.

The size of the nozzle 3 and the diameter of its cylindrical bore 8 in general vary with the grade of steel and the size of the ingot to be cast. As indicated above, the conventional practice has been to construct nozzles 3 having a length such that the axial length of the bore 8 is several times the orifice diameter for the purpose of obtaining a streamline flow of metal therethrough with as little turbulence and spraying as possible. However, such constructions have not been entirely effective in eliminating turbulence and spraying of the metal being teemed.

We have found that the flow characteristics of a liquid moving through a nozzle orifice 10 of the configuration shown in the drawings varies with the pressure head of the liquid in the vessel and with its velocity of flow through the bore 8. Generally stated, a streamline flow occurs at low pressure heads and velocities and the flow becomes turbulent as the pressure head and velocity increase. The turbulent condition of flow continues until the pressure head and velocity increase further to a point at which the flow abruptly reverts to a streamlined condition. During the intermediate regions of pressure heads and velocities giving rise to a turbulent flow, further investigations have shown that cavitation of the stream of liquid flowing through the orifice 10 takes place in a small annular area 12 at the upper end of the bore 8 and adjacent the circle 9. For purposes of illustration, this annular area 12 may be considered as extending between the circle 9 and dotted line 13. Pressure measurements have shown that a negative pressure of up to as much as 28 inches of mercury is produced in the annular area 12 at the surface of the bore 8 under turbulent conditions of flow. This negative pressure is a minimum when the flow initially becomes turbulent and increases as the flow becomes more turbulent under increased pressure heads and velocities.

In accordance with the principles of this invention, a streamline flow through the orifice 10 is obtained under all conditions of pressure heads and velocities by venting the area 12 to the atmosphere or other gaseous medium at atmospheric or above pressure. This is accomplished by drilling the nozzle 3 to provide a radially extending opening 14 which opens through the wall of the bore 8 into the orifice 10 in the annular area 12 thereof. A vertically extending opening 15 is bored in the nozzle 3 and has its upper end connected with the opening 14 and its lower end open to the atmosphere. If desired, the lower end of the opening 14 may be connected to a source of other suitable gas at a pressure approximating that of the atmosphere. With the area 12 vented in this manner by the openings 14 and 15, a streamline flow of liquid through the orifice 10, and particularly through the portion thereof provided by the bore 8, is had under all pressure heads and velocities which would otherwise be effective to cause a turbulent flow. In addition to eliminating turbulence, it will be apparent that the venting action provided by the openings 14 and 15 enables the use of nozzles 3 having a shorter axial length than

heretofore considered essential according to conventional practice. Although the drawings show only a single venting opening **14**, it will be understood that in actual practice a nozzle **3** will be provided with several such openings so that closing of one or more will not interfere with venting to the atmosphere as described.

While the above description and the showing in the drawings are specific to the use of the nozzle **3** in teeming molten metal from a ladle into an ingot, it will be understood that the disclosure in this respect represents a preferred embodiment and application of the invention. Accordingly, it will be further understood that a nozzle having a vent opening into the area **12** has general application to the end of obtaining a streamline flow of other fluids and that other adaptations and modifications are contemplated and may be made without departing from the scope of the following claims.

We claim:

1. In a refractory lined metal ladle having a teeming opening in the bottom thereof the combination with said ladle of, a nozzle comprising a refractory body mounted in said opening, said body having a conical well in the upper end thereof, a vertically extending cylindrical bore intersecting with said well and cooperating therewith to provide a teeming orifice arranged concentrically of said ladle opening, and a vent opening into said orifice at a point below and adjacent the intersection of said conical well and cylindrical bore and connecting said orifice to the atmosphere.

2. In a refractory lined metal ladle having a teeming opening in the bottom thereof the combination with said ladle of, a nozzle comprising a refractory body mounted in said opening, said body having a conical well in the upper end thereof, a vertically extending cylindrical bore intersecting with said well and cooperating therewith to provide a teeming orifice arranged concentrically of said ladle opening, and a vent comprising a first passageway extending radially through the wall of said bore and opening into said orifice at a point below and adjacent the intersection of said bore and well, and a second passageway extending axially through the wall of said bore and having its upper end intersecting with said first passageway and its lower end open to the atmosphere.

3. A method of obtaining a streamline flow of fluid through a discharge orifice in the bottom of a receptacle in which the discharge orifice is defined by a vertically extending nozzle body having a conical well in the upper end thereof and a cylindrical bore intersecting with and extending downwardly from said well, which comprises the step of venting said orifice to the atmosphere at a point in an annular area adjacent and immediately below the said intersection of said bore and well, to thereby prevent negative pressures in said annular area and cavitation of a fluid stream flowing through said orifice.

References Cited in the file of this patent

UNITED STATES PATENTS

1,090,044	Fuss	Mar. 10, 1914
1,261,509	Getman	Apr. 2, 1918
2,215,132	Parker	Sept. 17, 1940
2,348,199	Freeman	May 9, 1944
2,705,622	Laub	Apr. 5, 1955

FOREIGN PATENTS

808,711	France	Nov. 24, 1936