March 24, 1970 M. A. OREHOSKI 3,502,134

CONTINUOUS CASTING METHOD WITH INERT GAS PUFFS TO PREVENT SKULLING

Filed July 19, 1967 2 Sheets-Sheet 1

FIG. 1.

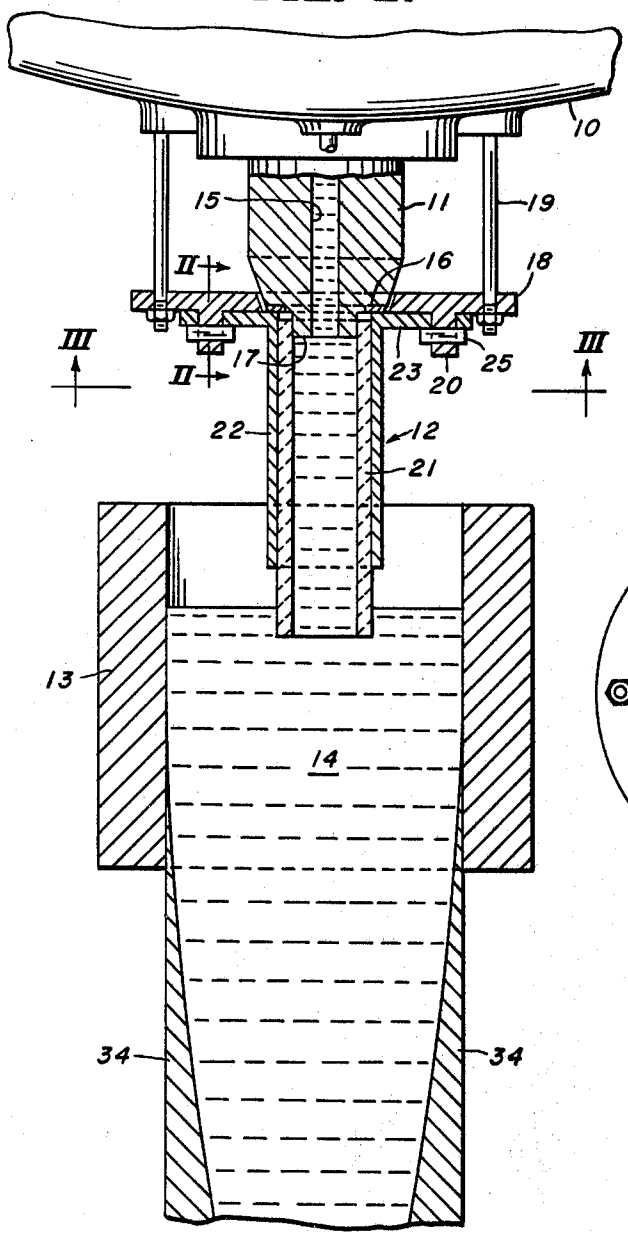


FIG. 2.

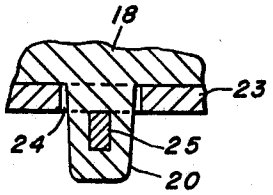
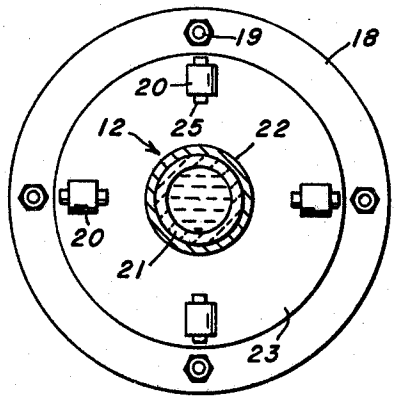


FIG. 3.



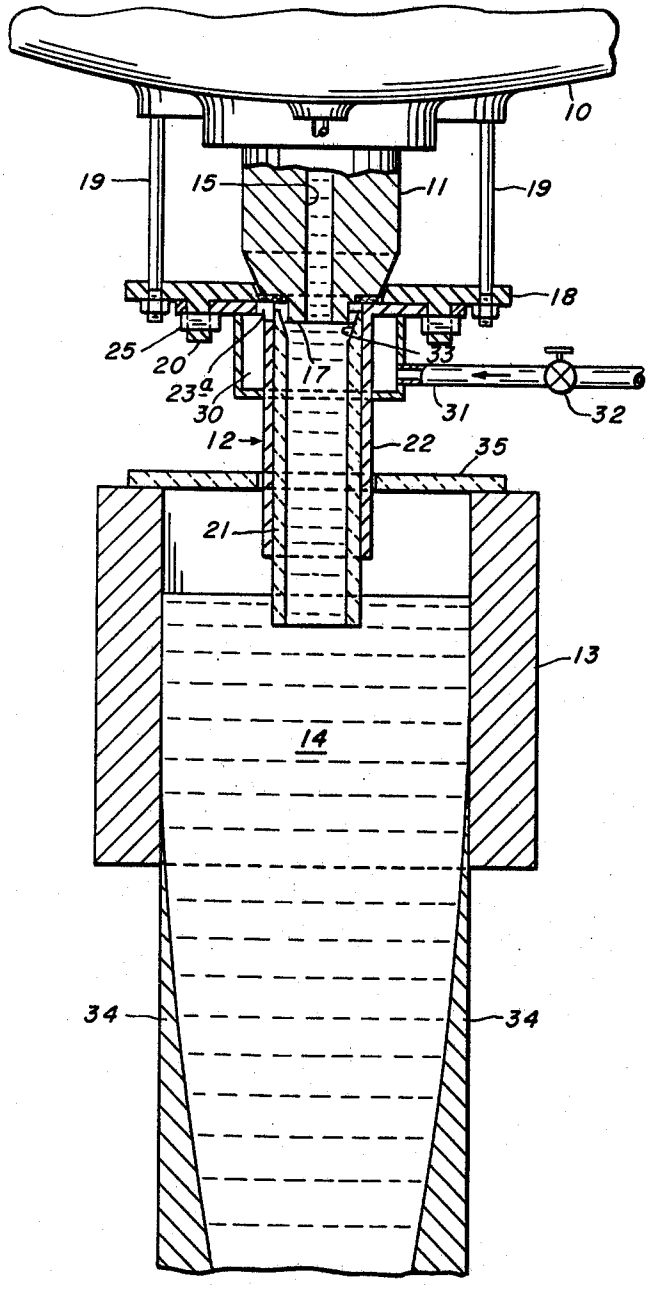
INVENTOR.
MICHAEL A. OREHOSKI
By Donald G. Dalton
Attorney

March 24, 1970 M. A. OREHOSKI 3,502,134

CONTINUOUS CASTING METHOD WITH INERT GAS PUFFS TO PREVENT SKULLING

Filed July 19, 1967 2 Sheets-Sheet 2

FIG. 4.



INVENTOR.
MICHAEL A. OREHOSKI
By Donald G. Dalton
Attorney

United States Patent Office 3,502,134
Patented Mar. 24, 1970

3,502,134

CONTINUOUS CASTING METHOD WITH INERT GAS PUFFS TO PREVENT SKULLING

Michael A. Orehoski, Duquesne, Pa., assignor to United States Steel Corporation, a corporation of Delaware

Continuation-in-part of application Ser. No. 446,529, Apr. 8, 1965. This application July 19, 1967, Ser. No. 654,637

Int. Cl. B22d *21/02, 11/10*

U.S. Cl. 164—66 2 Claims

ABSTRACT OF THE DISCLOSURE

A pouring tube substantially sealed to the nozzle in the bottom of a teeming vessel extends below the surface of metal in a mold below the vessel. A barometric leg is thus afforded the teeming stream. The tube is larger than the nozzle in cross-section so, as the air initially in the tube is exhausted by entrainment, it fills up with molten metal and the velocity thereof is reduced on entering the tube. This avoids damage to the solid skin of a continuously cast section being formed, by excessive agitation of the metal in the mold. Means providing a limited controlled injection of inert gas into the top of the tube may be employed to cause just enough agitation to prevent skulling on the exterior of the tube.

This is a continuation-in-part of my application Ser. No. 446,529, filed Apr. 8, 1965, now abandoned.

This invention relates to teeming molten metal from a holding vessel such as a ladle or tundish into a mold therebelow.

It has been shown in Austrian Patent No. 228,418, that advantages such as protection of the stream from atmospheric oxidation, avoidance of splashing, etc., may be obtained by the use of a pouring tube extending from the vessel to a level below that of the metal in the mold. The Austrian patent discloses the introduction of an inert gas into the pouring tube to displace air normally present therein and thereby reduce oxidation.

There is a further problem, however, in using a pouring tube, particularly for teeming into a continuous-casting mold, viz, the turbulence in the metal near the surface may be so great as to impair the integrity of the solid cast skin adjacent the walls of the mold. The impairment may be such as to lead to the occurrence of breakouts, after the casting leaves the mold, under the ferrostatic head thereabove. Also, even if a breakout does not occur by the conventional method of continuous casting, the turbulence produced during casting causes nonuniform erosion of the cast skin and this nonuniformity eventually leads to cracking during the rolling operation.

I have invented a method for teeming whereby the foregoing problems are largely obviated.

In a preferred embodiment and practice of the invention, I employ a pouring tube sealed substantially gas-tight to the vessel bottom over the outlet nozzle thereof and imperforate throughout its length to preclude the ingress of air. The sectional area of the pouring tube must be much greater than that of the outlet nozzle of the vessel. By reason of this combination when teeming is initiated and the liquid level in the mold rises above the lower end of the tube, the air initially present in the tube is quickly exhausted therefrom by entrainment with the descending metal stream. Eventually a vacuum is created in the tube and the metal level therein rises so as eventually to fill the tube. Thus on further teeming, metal draining through the vessel nozzle is decelerated by the increased section of the tube, compared to that of the nozzle, and descends therethrough at a reduced velocity

to prevent the scouring turbulence mentioned above. Furthermore, because there is a fluid connection between the vessel and the mold, air is not entrained into the liquid metal in the mold. Thus, oxidation of the liquid steel is minimized. Skulling of metal may tend to occur on the exterior of the tube at the lower end thereof. If so, this may be prevented by admitting a carefully controlled and restricted amount of inert gas into the upper end of the tube to produce a slight turbulence effective to prevent skulling without causing scouring of the casting skin. This skulling may be further inhibited by radiation shields attached to the tube above the level of the liquid metal in the mold.

A complete understanding of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating the present preferred embodiment. In the drawings:

FIGURE 1 is a central vertical section through a vessel for holding molten metal, having the invention incorporated therewith, and the mold therebelow as well as the casting formed in and issuing therefrom;

FIGURES 2 and 3 are sections taken, respectively, along the planes of lines II—II and III—III of FIGURE 1; and

FIGURE 4 is a view similar to FIGURE 1 showing a modification.

Referring now in detail to the drawings and, for the present, particularly to FIGURES 1–3, a vessel **10** for holding molten metal, such as a ladle or tundish has a bottom outlet terminating in a nozzle **11**. A pouring tube **12** sealed at its upper end to the lower end of the nozzle and of greater inside diameter than the bore **15** of the nozzle, extends downwardly therefrom into a continuous-casting mold **13** to a level below that at which the surface of the bath **14** of liquid metal therein is normally maintained. The joint between the nozzle and tube is made gas tight by a sealing ring **16** therebetween.

Tube **12** comprises a sleeve **22** having a flange **23** at the upper end, and a refractory liner **21** which is the only portion extending into the bath **14**. The lower end of nozzle **11** is reduced to fit into liner **21**. A horizontal mounting plate **18** is suspended on hanger studs **19** from vessel **10** and has depending lugs **20** on its bottom surface with horizontal holes therethrough. Flange **23** has holes to accommodate lugs **20** and is held tightly flush against plate **18** by keys **25** inserted through the holes in the lugs.

Liner **21** is imperforate, at least in the portion below the lower end of sleeve **22**. As a result, when metal is initially teemed through tube **12**, the air therein is quickly exhausted by entrainment with the metal, starting as soon as the level of bath **14** rises above the lower end of liner **21**. As the vacuum in tube **12** increases, the level of metal rises therein until the tube is substantially full. This occurs because the height of the metal column above the surface of the bath **14** is less than about 57", the height of column which equals atmospheric pressure. The vessel **10**, its nozzle **11** and tube **12** therefore together constitute a barometric leg in which the metal column is sustained by atmospheric pressure on the surface of the bath **14**.

In consequence, the velocity of metal flowing through bore **15** is reduced on entry into liner **21** because of the greater sectional area thereof. Metal thus flows from liner **21** into the liquid metal **14** at such low velocity that there is no danger of its impairing the integrity of skin **34** by washing or erosion. The surface of the bath remains practically quiescent. This condition, in fact, gives rise to a secondary problem, viz., a possible tendency toward skulling, of the metal around the exterior of the immersed lower end of liner **21**. This condition, however, may be easily cured by intentionally causing a slight turbulence

on the surface of the bath by the modification shown in FIGURE 4.

FIGURE 4 shows generally the same arrangement of parts as already described except that the upper end of liner **21** is relieved or countersunk as at **33**, and a manifold **30** is provided, extending around the lower end of nozzle **11** and the upper end of tube **12**. The manifold has a connection to a source of inert gas, including a control valve **32**. Flange **23** has slots **23***a* at 120° angles to admit gas from the manifold to the countersink **33**. By this arrangement, a small puff of gas may be entrained with the metal stream on cracking valve **32** periodically. This gas, on emerging from the lower end of the tube **12**, agitates the surface of bath **14** sufficiently to prevent skulling on the immersed lower end of liner **21**.

This effect may alternatively be attained by the provision of a radiation shield in the form of a refractory cover **35** on top of the mold.

It will be evident that maintenance of a barometric leg in the descending metal stream causes the velocity thereof to be reduced on entering liner **21** so bath **14** will not be agitated enough to affect skin **34**.

Although I have disclosed herein the preferred embodiment of my invention, I intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention as set forth in the claims.

What is claimed is:

1. In a method of continuously teeming molten metal from a vessel into an open-ended mold wherein the metal forms a bath whose surface has a normal level, said vessel having a pouring nozzle in its bottom wall spaced above said mold, said method comprising:

passing the metal through a tube which has imperforate walls and extends downwardly from said nozzle with its lower end immersed in said bath;

excluding air from the outside from entering the upper end of said tube;

the bore of said tube being larger in cross section than the bore of said nozzle;

exhausting air initially present in said tube by entrainment in the metal passing therethrough; and

raising the level of metal in said tube above said normal level, whereby metal enters the bath at a low velocity and the bath surface tends to remain quiescent;

the improvement comprising:

admitting controlled puffs of inert gas periodically to the upper portion of said tube; and

confining said gas throughout the length of the tube so that it escapes only through the immersed lower end and agitates the bath sufficiently to prevent skulling without causing scouring of the casting skin.

2. A method as defined in claim **1** comprising in addition applying a heat shield over the top of said mold.

References Cited

UNITED STATES PATENTS

1,417,269	5/1922	MacMichael et al.	164—337
2,023,957	12/1935	Hewgill	164—66
2,290,083	7/1942	Webster	164—337 X
3,174,200	3/1965	Keel et al.	164—66
3,395,831	8/1968	Minteer	222—567 X
3,253,307	5/1966	Griffiths et al	222—1

FOREIGN PATENTS

872,634	4/1953	Germany.
228,418	7/1963	Austria.
1,395,648	3/1965	France.

ROBERT D. BALDWIN, Primary Examiner

U.S. Cl. X.R.

164—82