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DISCHARGE MECHANISM FOR BOTTOM POURING STEEL LADLE

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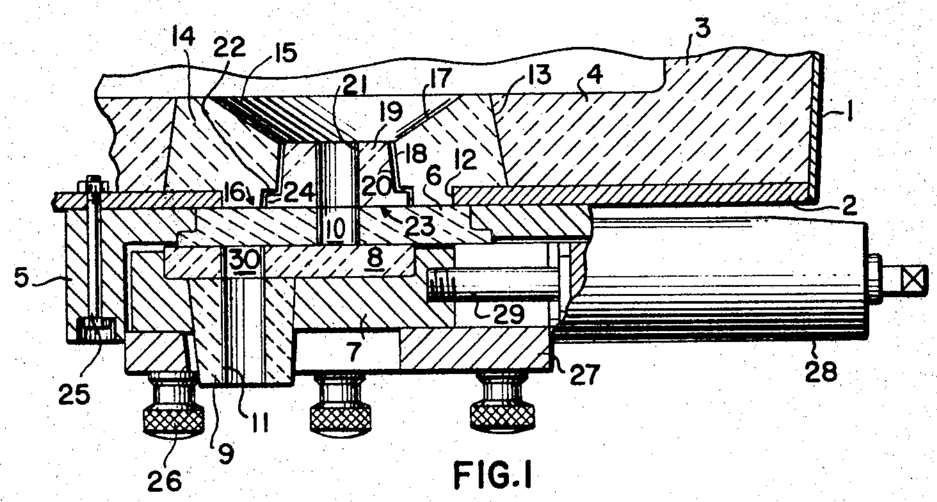

FIG. 1

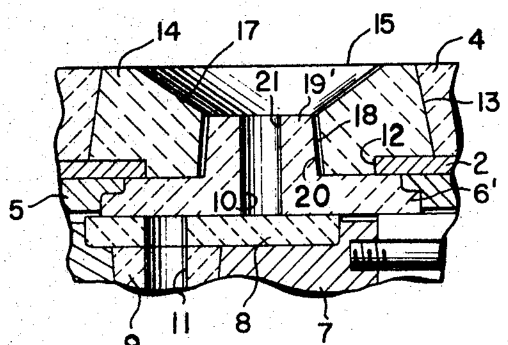

FIG. 2

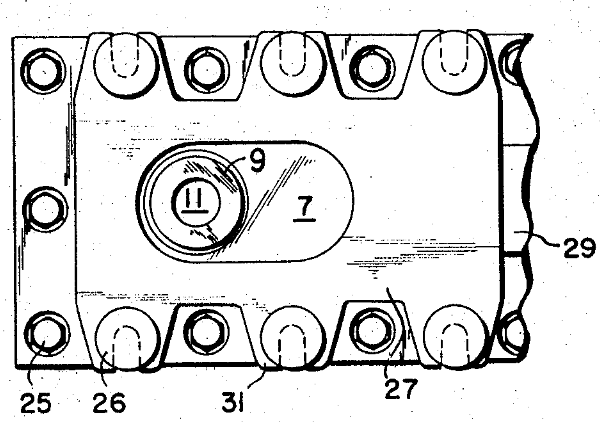

FIG. 3

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DISCHARGE MECHANISM FOR BOTTOM POURING STEEL LADLE

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Claims priority, application Italy, Sept. 22, 1964, 20,355/64
Int. Cl. B65d *47/26;* B67d *3/00;* B22d *37/00*
U.S. Cl. 222—531 2 Claims

ABSTRACT OF THE DISCLOSURE

A bottom pouring steel ladle having a well in the bottom of its lining and a downwardly flaring tubular plug in the bottom of the well to form a portion of the pouring duct is equipped with an apertured, horizontally movable gate held against the outside of the ladle shell by clamping screws in pressure transmitting engagement with the plug to retain the same in its operative position.

This application is a continuation of Ser. No. 488,654 filed Sept. 20, 1965, now abandoned.

This invention relates to steel making, and particularly to a discharge mechanism for a bottom pouring steel ladle.

It is known to equip ladles for steel making and related purposes with an opening in their bottom plate which can be obstructed by a gate mechanism mounted on the outside of the ladle shell and movable across the opening in the bottom plate.

The known devices of this type have many advantages, but their refractory elements are subject to relatively rapid erosion by the hot melt when the latter is poured from the bottom plate opening, and require frequent replacement. Such replacement is costly in material and labor, and requires the ladle to be withdrawn from operation for a relatively long period.

An object of the invention is the provision of a discharge mechanism for a bottom pouring ladle whose refractory elements are more resistant to attack by the molten metal than elements of the same material in the known devices.

Another object is the provision of a discharge arrangement in which metal attack is concentrated on a small, disposable refractory element which may be replaced at small cost, and in which the disposable refractory element can be replaced simply, rapidly, and without requiring shutdown of the ladle for an appreciable time.

With these and other objects in view, as will hereinafter become apparent, the invention in one of its aspects resides in the specific configuration of a well aligned with the opening in the bottom plate and having a common axis with a pouring duct which leads outward of the ladle shell through the opening. The well and a portion of the duct are defined by the refractory lining in the shell. The well has a side wall which tapers toward the duct, and a relatively wide annular bottom wall about an orifice of the duct, the bottom wall being angularly offset from the side wall toward the common axis.

The duct orifice and respective portions of the bottom wall and of the duct contiguously adjacent the orifice are constituted by a well insert which is a part of the lining and is axially movable relative to the tapering side wall of the well. The well insert is retained in position against axial outward movement by means which include a gate assembly mounted on the outside of the shell and sealingly engaging the lining. Another portion of the pouring duct extends through the gate assembly which may be moved transversely of the common axis of well and duct toward and away from a position of axial alignment of the duct portions.

Other features and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing in which:

FIG. 1 shows a steel ladle equipped with the discharge mechanism of the invention in fragmentary, elevational, sectional view.

FIG. 2 shows a modification of the device of FIG. 1; and

FIG. 3 is a fragmentary bottom plan view of the device of FIG. 1, and similarly illustrative of the device of FIG. 2.

Referring now to the drawing in detail, and initially to FIG. 1, there is seen a portion of a steel ladle of the general type illustrated and described in "The Making, Shaping and Treating of Steel" (U.S. Steel Co., 6th ed., 1951), pages 448–452, but provided with the discharge mechanism of the invention. The outer metal shell of the ladle includes a side wall **1** and a bottom plate **2**, and is protected over most of its inner surface by a refractory lining of which a portion **3** extends over the side wall **1** and a bottom portion **4** covers the bottom plate **2** with the exception of an annular area about a circular opening **12** in the plate **2**.

The portion of the plate about the opening **12** is protected by a refractory well block **14** of circular cross section. Its conical outer wall **13** tapers upwardly and is engaged by the bottom lining **4**. Its top face **15** is flush with that lining. An integral annular ridge portion **16** of the block **14** extends into the opening **12**, and its bottom face is flush with that of the plate **2**. The block **14** is thereby locked in position by the lining portion **4**.

A vertical axial passage through the well block **14** has a conical wall **17** which tapers sharply downward from the top face **15**. The central passage portion **18** is also conical, but it flares gently in a downward direction. A shoulder in the passage connects the central portion **18** with a terminal cylindrical portion **22** of greater diameter.

A replaceable, plug-shaped, refractory well insert **19** is conformingly received in the passage portions **18** and **22**. The annular top face of the insert **19** forms the flat horizontal bottom of a well whose sides are formed by the wall **17** of the block **14**. A conical outer wall **20** of the insert **19** is axially approximately coextensive with the central passage portion **18**, and a terminal integral flange **24** at the bottom end of the insert **19** is received in the cylindrical passage portion **22** and abuts against the shoulder of the well block **14**. The bottom face **23** of the insert **19** is flush with that of the ridge portion **16**.

A cylindrical axial bore **21** in the insert **19** is aligned with an aperture **10** of the same cross section in a refractory plate **6** whose size is sufficient to cover the opening **12** in simultaneous abutting engagement with the bottom faces of the base plate **2**, the ridge portion **16**, and the insert **19**. The plate **6** is laterally held in position by a steel frame **5** attached to the base plate **2** by bolts **25**, and slightly projects downward from the frame.

Heavy clamping screws **26** secure a cover **27** to the frame **5**. The flat top face of the cover **27** supports a horizontally movable steel gate **7**. The vertical position of the cover **27** is adjustable by means of the screws **26** in such a manner that an apertured plate **8** of refractory material which is set into the gate **7** and projects slightly above the top face of the same, is urged upward into sealing engagement with the plate **6**, and thereby prevents movement of the plate **6** away from the insert **19**.

A double acting hydraulic cylinder **28** is mounted on the frame **5**. Its piston rod **29** is fastened to the gate **7** to move the gate toward and away from a non-illustrated pouring position in which the aperture **30** in the movable plate **8** is coaxially aligned with the substantially identical aperture **10** of the stationary plate **6**.

A nozzle of downwardly tapering conical external shape is fastened in the gate **7** subjacent the plate **8** in such a manner that the bore **21**, the apertures **10**, **30** and an axial passage **11** in the nozzle **9** constitute a continuous uniform, cylindrical pouring duct from the interior of the ladle to the ambient atmosphere. The nozzle **9** projects downward through an opening in the cover **27** which is shaped to permit the movement of the nozzle **9** with the gate **7**.

It will be understood that conventional refractory powder is being used for providing seals between the several elements of the discharge mechanism which do not move relative to each other during normal operation, and such seals have not been illustrated.

In the modified embodiment of the discharge mechanism illustrated in FIG. 2, the plug insert **19'** and the stationary plate **6'** form a unitary integral insert which combines all features and functions of the separate elements **6** and **9** described hereinabove.

FIG. 3 shows in more detail how the cover **27** is fastened to the frame **5**. Six bifurcated lugs **31** of the cover are slidably received in corresponding notches of the frame **5**, and are abuttingly engaged by the screws **26**.

The discharge mechanism of the invention is operated as follows:

When a melt is ready to be poured from the ladle, the non-illustrated hydraulic circuit of the cylinder **28** is actuated to shift the gate **7** toward the right, as viewed in FIGS. 1 and 2, until the apertures **10**, **30** are axially aligned. The molten steel passing through the pouring duct attacks mainly the well insert **19**, and particularly the surfaces at the orifice of the bore **21** in the top face.

The static pressure of the liquid metal is highest on the flat top face of the insert **19**, and significantly higher than on the conical wall **17** of the well block **14**. Turbulence in the melt is highest at the orifice of the bore **19** and decreases sharply in the pouring duct in a direction away from the top orifice. There is a minor amount of turbulence in the well due to the obtuse angle enclosed by the wall **17** and the top face of the insert **19**. Such turbulence, however, has been found to keep the velocity of the metal at the wall **17** significantly lower than would be the case if the top face of the insert **19** formed a continuous conical surface with the wall **17**.

The protection afforded to the conical wall **17** is directly related to the radial width of the annular bottom wall of the well between the orifice of the pouring duct and the wall **17**. In the illustrated preferred embodiments of the invention, the cross section of the orifice is substantially less than a quarter of the minimum cross section of the well as defined by the wall **17**. If the cross section of the orifice is equal to or greater than one half of the area of the bottom wall, an obtuse angular relationship of the wall **17** to the top face of the insert **19** cannot materially reduce metal attack on the wall **17**. The top face **15** of the well block **14** is so far from the orifice of the bore **21** that it is only subjected to the effects of metal flowing at relatively low velocity. No other surfaces of the well block being exposed to the melt, the block has a long useful life.

The turbulence in the flowing metal is so much reduced by passage through the bore **21** that the plate **6** needs to be replaced relatively infrequently under many conditions of operation. I prefer to use the arrangement illustrated in FIG. 1 under such conditions. The well insert **19** can be replaced quickly and conveniently without an extended shutdown of the ladle. The cover **27** is quickly released by the screws **26**, thereby permitting the removal of the gate **7** with the plate **8** and nozzle **9**. The plate **6** is then taken from the frame **5**, and the insert **19** is knocked out from the inside of the ladle. A new insert is placed in position, and the discharge mechanism is quickly assembled again. The ladle is immediately ready for receiving the next melt.

The small insert **19** may be made of refractory material inexpensive enough to permit replacement after each pouring operation. It is so small, however, that it is entirely practical to make it of high-grade refractory material which withstands several heats of molten steel without requiring replacement.

The dimensions of the movable refractory plate **8** and the nozzle **9** are relatively non-critical. They normally withstand a considerable number of pouring operations, and may be replaced quickly, if needed.

Where the temperature, pressure, and other properties of the melt favor attack on the pouring duct, it may be advisable either to replace both the insert **19** and the stationary plate **6** at relatively short intervals, or to make both of highly resistant and correspondingly costly refractory material. Under such conditions, the modified structure illustrated in FIG. 2 is preferred.

The tightness of the discharge mechanism is due mainly to the abutting engagement of the several elements which jointly constitute the well and the pouring duct, and which seal the duct between pouring operations. This engagement is maintained by the cover **27** and the screws **26**, and is therefore adjustable as needed. The refractory material interposed between elements of the mechanism which do not move relative to each other is not subjected to significant mechanical or chemical stresses, and has only an auxiliary function.

At least some of the advantages of this invention may be achieved in modified discharge mechanisms which do not embody every feature illustrated and described hereinabove. Removal of the insert **19** from the well block **14** in a direction outward of the ladle is impossible if the passage in the block tapers downward from the wall **17**. While it is preferred that the central portion **18** of the passage diverge in a downward direction, such divergence is not absolutely necessary if the flange **24** limits the inward movement of the insert **19** and provides precise centering. Conicity also is not required in the plug portion **19'** which is integral with a stationary plate portion **6'** as shown in FIG. 2, although it facilitates sealing of the insert to the well block **14**.

Similarly, the ridge portion **16** of the well block **14** which directly engages the top face of the stationary plate **6** is preferred, but the opening **12** may be reduced in size to eliminate the ridge portion without making the apparatus inoperative.

Obviously, many other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically disclosed.

What is claimed is:

1. In a bottom pouring ladle adapted to hold a body of molten metal, in combination:

(a) a shell having a bottom plate and formed with an opening in said bottom plate, the opening having a vertically extending axis;

(b) a refractory lining in said shell, the lining forming the side wall of a downwardly tapering well axially alinged with said opening;

(c) insert means partly received in said lining, said insert means having

(1) a plug portion forming an annular bottom wall of said well and being dimensioned for axial movement through said opening and out of said lining and of said shell, and

(2) a plate portion substantially obstructing said opening and contiguous to said plug portion, said plate portion having a downwardly directed face outside said shell,

(3) said plug portion and said plate portion being formed with respective, aligned, axial portions

of a pouring duct having an orifice centered in said annular bottom wall;

(d) a gate assembly mounted on the outside of said shell,

(1) said gate assembly including a plate member formed with another portion of said duct;

(e) actuating means for moving said gate assembly transversely of said axis toward and away from a position of axial alignment of said portions of said pouring duct; and

(f) clamping means on said shell for axially urging said gate assembly upward into sealing abutting engagement of said plate member with said face of said plate portion,

(1) said clamping means in cooperation with said gate assembly constituting the only means preventing movement of said plug portion outward of said shell through said opening under the pressure on said bottom wall exerted by a body of metal held in said ladle.

2. In a ladle as set forth in claim **1**, said plug portion and said plate portion having respective faces transverse of said axis, said faces being held in abutting engagement by said clamping means when the clamping means upwardly urge said gate assembly into said abutting engagement of said plate member and of said face of the plate portion.

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WALTER SOBIN, *Primary Examiner.*

U.S. Cl. X.R.

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