United States Patent [19]

Fehling

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[54] **SLIDE CLOSURE PLATES AND METHOD FOR PREVENTING MELT PENETRATION**

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[30] **Foreign Application Priority Data**

Apr. 27, 1973 United Kingdom..... 20118/73

[52] **U.S. Cl.** **222/542**; 137/246.22; 222/512; 222/561

[51] **Int. Cl.**..... **B22d 37/00**

[58] **Field of Search**..... 137/246.14, 246.22; 222/512, 542, 561, DIG. 7

[56] **References Cited**

UNITED STATES PATENTS

2,918,938	12/1959	Kimball	137/246.22 X
3,349,789	10/1967	Crain et al.	137/246.22
3,583,692	6/1971	Urso	222/561 UX
3,651,998	3/1972	Rocher	222/542 UX

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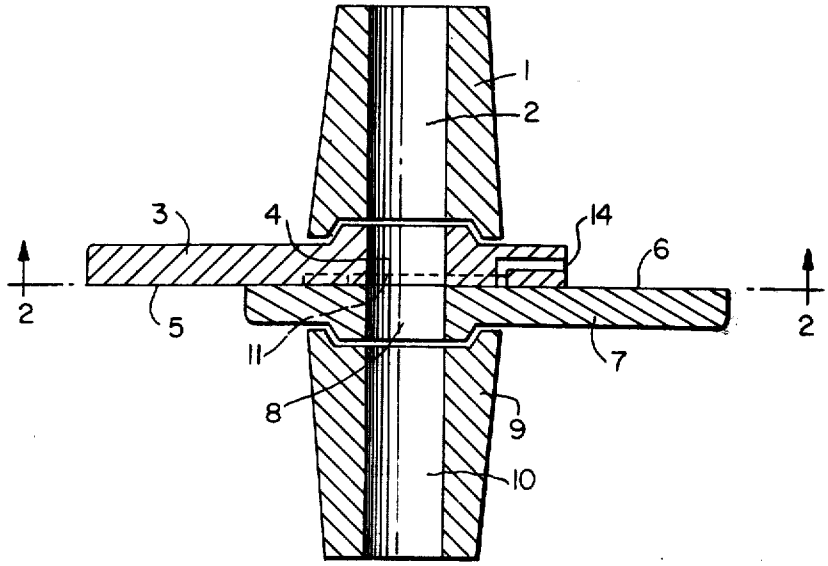
[57] **ABSTRACT**

A U-shaped channel is formed in the sliding surface of the bottom plate, and also if desired in the sliding surface of the slide plate. Inert gas is supplied to the channel at a suitable pressure to prevent penetration of the metal melt into the space between the plates and the pores of the refractory material of the plates.

6 Claims, 5 Drawing Figures



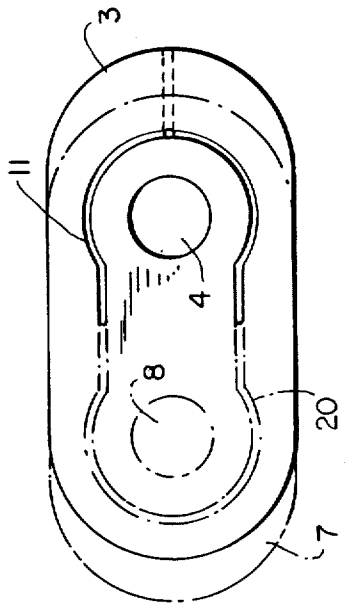


FIG. 3

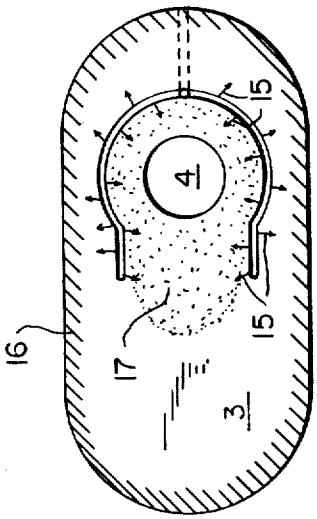


FIG. 4

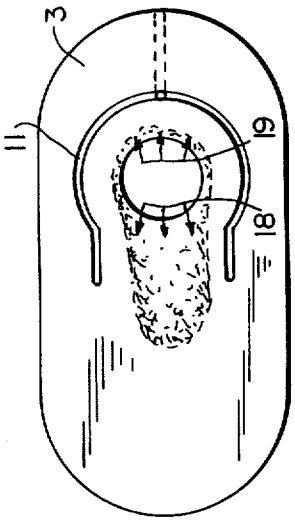


FIG. 5

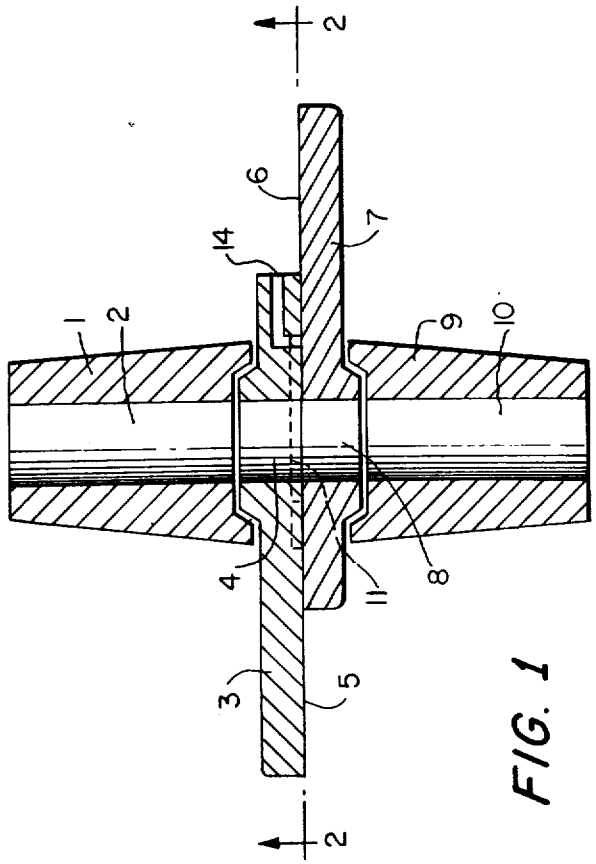


FIG. 1

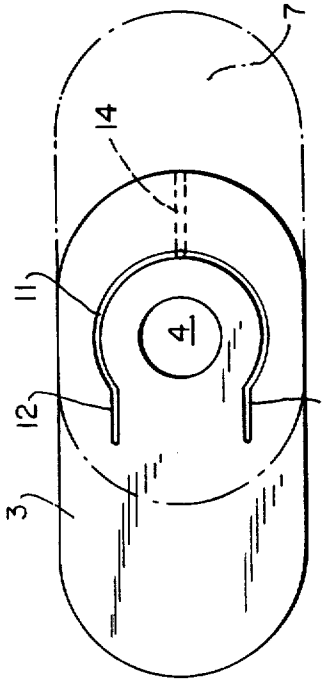


FIG. 2

SLIDE CLOSURE PLATES AND METHOD FOR PREVENTING MELT PENETRATION

BACKGROUND OF THE INVENTION

The invention relates to a pair of refractory plates, specifically a fixed bottom plate and movable slide plate, each provided with a through-flow opening, for a slide closure on the spout of a liquid-metal containing vessel, in particular a large capacity steel-pouring ladle.

When slide closures have in the past been employed on steel-pouring ladles having a capacity of more than 100 tons, considerable difficulties resulted due to blocking of the closure mechanism after only a few raw ingots were poured. The blocking usually takes place during the closing of the slide.

As is well known, the main parts of a slide closure include a pair of refractory plates, namely a fixed bottom plate and a movably-arranged slide plate. The plates slide in a very close contact on each other, to a position with their through-flow openings in alignment for the purpose of opening the closure, or to a position with their openings spaced from each other for the purpose of closing the slide closure. The contact surfaces of the plates are very smooth and plane and are polished to a tolerance of, for example, less than 0.05 mm. The plates are formed of very high-quality refractory material, generally either of a material having a high content of alumina, such as aluminum oxide, or of the highest quality magnesite material.

In spite of such high quality materials, the above-mentioned blocking still takes place and considerable damage to the plates in the vicinity of the through-flow openings occur, even though the operational time is very short, i.e. no more than ten to twenty minutes.

It is assumed that the blocking and the premature destruction of the plates in the area of the through-flow openings are due above all to the penetration or infiltration of liquid metal into the pores of the plates and/or the very narrow intermediate spaces between the contact surfaces of the slide plate and the bottom plate under the influence of the very high ferrostatic pressure existing in a high-capacity vessel. Steel normally does not wet the above-mentioned refractory materials, so that there is no substantial penetration as long as the ferrostatic pressure is lower than the opposing capillary pressure. As the capacity of the vessel increases and the level of the bath becomes correspondingly higher, the value of the ferrostatic pressure reaches a critical value at which melt penetration will occur. During such melt penetration, steel is removed from the hot main stream, so that the penetrating steel cools down and then solidifies. This phenomenon forms a thin wedge of solidified steel between the plates, which initially increases the slide friction and later leads to blocking and destruction of the plates.

SUMMARY OF THE INVENTION

The object of the present invention is to overcome the above-mentioned difficulties, and in particular to prevent the penetration of the metal melt between the plates of the slide closure.

This object is achieved in accordance with the present invention by providing on at least the sliding surface of the stationary bottom plate a U-shaped channel extending around the through-flow opening and by providing a connection for inert gas into the channel. The ends of the legs of the channel are separated from each other by a distance which exceeds the dimension of the diameter of the through-flow opening of the slide plate which moves between such leg ends. Due to this structural arrangement, the space around the through-flow opening of the bottom plate can be subjected to the action of pressurized gas which will increase the resistance in the pores and intermediate spaces of the refractory plates to the penetration therein of the melt. Thus, the penetration of the melt into the pores and intermediate spaces and the above-mentioned formation of a wedge by the solidified melt is counteracted, so that the proper operational condition of the plates remains fully preserved beyond the customary time period, even when employing vessels possessing a relatively high capacity. The through-flow opening of the slide plate can slide between the legs of the U-shaped channel during the opening or closing movement of the slide closure, so that the gas pressure in the channel, which is covered by the sliding surface of the slide plate, remains preserved in every phase of movement of the slide plate. This guarantees an economical consumption of gas.

In many cases it is expedient to provide a U-shaped channel in the sliding surfaces of both plates, i.e. of the bottom plate and of the slide plate, the ends of such channels facing each other and coinciding in the closed position of the plates. The through-flow openings of the two plates are thus surrounded by an endless channel, through which the inert gas can be introduced into the area of the plates which is subjected to the danger of melt penetration.

The channel advantageously surrounds the through-flow opening at a distance corresponding to the opening thereof, and the inert gas connection expediently is connected to the channel in the curved portion thereof.

In the case of wetting metals, such as copper, a concave meniscus is formed in the pores and intermediate spaces between the plates, which meniscus is not capable of counteracting the tendency of melt penetration. On the contrary, such meniscus assists such penetration. In this case, to prevent the penetration of liquid metal between the bottom and slide plates and into the pores of the refractory plate material in the area of the through-flow opening of a slide closure for the spout of a liquid-metal containing vessel, it is necessary to produce a gas pressure in the such area through the introduction of inert gas, which pressure equals or is greater than the total pressure which effectively brings about the penetration or infiltration.

For pouring metals that do not exhibit a wetting effect, in accordance with the present invention it is necessary to introduce pressurized inert gas into such area, whose pressure difference in relation to the ferrostatic pressure is smaller than the capillary pressure, which results from the surface tension of the poured metal and the size of the existing pores, intermediate spaces or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained by way of example in the following text by means of the attached drawings, wherein:

FIG. 1 is a sectional view of a slide closure, including a bottom plate and a slide plate, in the open position, in accordance with the present invention;

FIG. 2 is a view, taken along line II—II in FIG. 1, of the bottom plate with the slide plate indicated by phan-

tom lines to illustrate the open position of the closure;

FIG. 3 is a view similar to that of FIG. 2, but illustrating in phantom lines the closed position of the closure, and also illustrating a channel in the slide plate;

FIG. 4 is a view similar to that of FIG. 2, but also schematically illustrating the flow of inert gas; and

FIG. 5 is a view similar to that of FIG. 2, but also schematically illustrating the penetration of the metal melt.

DETAILED DESCRIPTION OF THE INVENTION

In the drawings, numeral 1 indicates an inlet sleeve which is arranged in a known manner in an apertured brick of the spout of a metal-melt containing vessel, such brick not being illustrated as it forms no part of the present invention. Inlet sleeve 1 has an opening 2 therethrough, and a stationary bottom plate 3 is fixed to the bottom of sleeve 1 with a through-flow opening 4 thereof coaxially aligned with through-flow opening 2. A sliding surface 5 of bottom plate 3 is in sliding contact with a sliding surface 6 of a movable slide plate 7 which has a through-flow opening 8 therein. An outlet sleeve 9 having a through-flow opening 10 therein is rigidly fixed to the bottom of slide plate 7 with through-flow openings 8 and 10 coaxially aligned.

Slide plate 7 and outlet sleeve 9 are mounted in a normal manner in a metal frame which is mounted in displaceable manner on the bottom of the vessel and is not illustrated as it forms no part of the present invention. Plate 7 and sleeve 9 can be shifted back and forth from the open position illustrated in FIGS. 1 and 2 into the closed position illustrated in FIG. 3.

According to FIGS. 1 and 2, the bottom plate 3 is provided in the bottom surface 5 thereof with a U-shaped channel 11 which surrounds through-flow opening 4 in such a manner that the ends of two legs 12 and 13 of the channel extend toward the direction of movement of the slide plate to the closed position thereof. The ends of legs 12 and 13 are separated from each other by a distance which allows the movement of through-flow opening 8 of slide plate 7 between the ends of legs 12 and 13 during the closing and opening operations. A gas connection 14 extends through bottom plate 3 to the curved portion of U-shaped channel 11. Inert gas can be introduced from the exterior through connection 14 into the duct formed by channel 11 and sliding surface 6 of slide plate 7.

The inert gas introduced, e.g. argon or nitrogen, is introduced under a given pressure and flows in the manner indicated in FIG. 4 by arrows 15 from channel 11. The gas moving outwardly from channel 11 in the direction of the plate periphery is prevented from escaping by a sealing edge zone 16 about the adjoining edges of plates 3 and 7. The gas moving inwardly from channel 11 acts on a zone 17 which is subjected to the danger of penetration by the metal melt. The gas-flow thus prevents the penetration of such melt from through-flow openings 4 and 8 of plates 3 and 7 into the intermediate spaces between the plates and into the pores of the refractory material thereof.

Arrows 18 in FIG. 5 show the general direction of the melt penetration during the closing movement of slide plate 7, while arrows 19 indicate the direction of melt penetration during the opening movement of slide plate 7. The gas flow and penetration flow indications of FIG. 4 and FIG. 5 may differ somewhat from case to case.

According to FIG. 3, an additional channel 20 is provided in surface 6 of slide plate 7. The two channels or grooves 11 and 20 supplement each other and form a continuous loop in any possible position of slide plate 7, which loops extend around through-flow openings 4 and 8.

As an alternative, the slide plate may perform a rotary movement or a partial rotary movement.

I claim:

1. In a slide closure for the spout of liquid metal containing vessels, particularly large capacity steel-pouring vessels, such slide closure including a fixed bottom plate and a movable sliding plate, each of said plates having through-flow openings therethrough and contacting sliding surfaces, the improvement comprising:

a U-shaped channel in the sliding surface of said bottom plate around the through-flow opening thereof, the ends of the legs of said channel being spaced from each other by a distance greater than the diameter of the through-flow opening in said slide plate;

said slide plate through-flow opening, during sliding movement of said slide plate, being movable between said channel legs; and

means for supplying inert gas to said channel.

2. The improvement claimed in claim 1, wherein said supplying means comprises an inert gas connection entering said channel at the curved portion thereof.

3. The improvement claimed in claim 1, wherein said channel surrounds said bottom plate through-flow opening at a distance equal to the radius thereof.

4. The improvement claimed in claim 1, further comprising a U-shaped channel formed in the sliding surface of said sliding plate, the ends of the legs of which extend toward said legs of said channel in said bottom plate, said ends of said legs of both said channels coinciding in the closed position of said slide closure.

5. The improvement claimed in claim 4, wherein said slide plate channel surrounds said slide plate through-flow opening at a distance equal to the radius thereof.

6. The improvement claimed in claim 5, wherein said bottom plate channel surrounds said bottom plate through-flow opening at a distance equal to the radius thereof.

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