

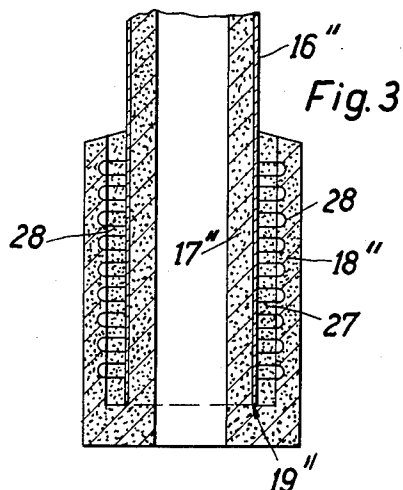
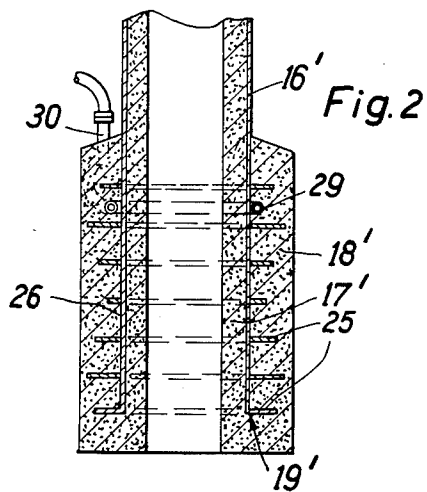
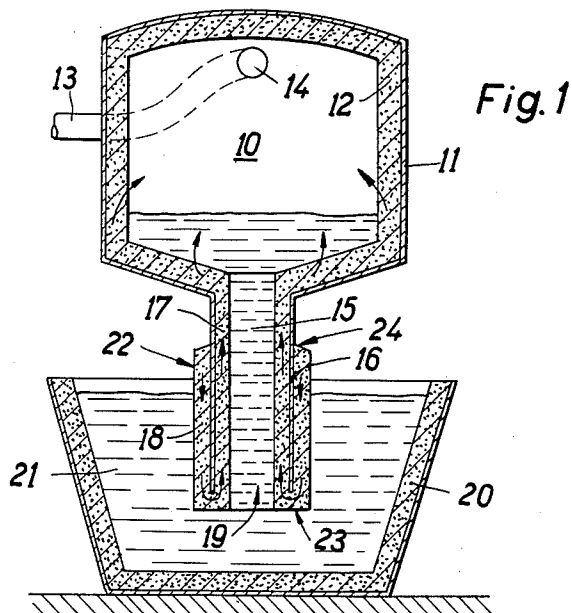
Oct. 2, 1962

H. KNÜPPEL ET AL

3,056,595

REFRACTORY NIPPLE FOR DIPPING INTO MOLTEN METAL

Filed Sept. 10, 1959



Inventors:
HELMUT KNÜPPEL,
KARL BROTZMANN
by *Master & Hollin*
ATTORNEYS

1

3,056,595

REFRACTORY NIPPLE FOR DIPPING INTO
MOLTEN METAL

Helmut Knüppel, Dortmund-Lottringhausen, and Karl Brotzmann, Dortmund, Germany, assignors to Dortmund-Hörder Hüttenunion Aktiengesellschaft, Dortmund, Germany

Filed Sept. 10, 1959, Ser. No. 839,156

Claims priority, application Germany Sept. 19, 1958

5 Claims. (Cl. 266—34)

The invention relates to a refractory nipple for dipping into molten metal, having a wall of low gas penetrability consisting of a gastight jacket lined internally and, at the immersion end, also externally with refractory ceramic material. Such nipples are employed, for example, in equipment for degassing steel.

In the known methods of industrial processing of molten steel under reduced pressure, the melted steel is customarily exposed to the action of reduced pressure before or during the pouring operation. For this purpose, it is necessary to transfer the steel, at atmospheric pressure, to vessels in which a negative gauge pressure prevails. Special difficulties have arisen in this connection with the construction of passages through which the molten steel is to reach the reduced-pressure chamber. It has been found that when the passages are enveloped with refractory material in the conventional manner, undesirable and sometimes excessive quantities of air leak into the reduced-pressure chamber at these points.

To combat this effect, it is possible to imbed steel plates in the refractory material, these plates being joined in vacuum-tight manner to the jacketing of the evacuation vessel at one end and in intimate contact with the steel at the other end. This, at least in theory, ensures an absolute seal.

If such sealing plates are not to be completely liquefied by the molten steel, they must be cooled. This represents a technical difficulty. Furthermore, operational dependability is inadequate. For in the industrial processing of liquid steel, slag formation is inevitable. But if slag is deposited at the steel plate, unbroken intimate contact with the liquid steel is lost. This may result in cracks through which air will enter the vacuum vessel.

The invention is based on the discovery that the gas penetrability of the refractory ceramic materials conventionally used for liners, insofar as due to genuine porosity, is by no means so great as to be able to interfere appreciably with the processing of molten steel under reduced pressure; on the contrary, the penetrating gas volumes enter almost exclusively, in actual fact, where microscopic cracks or fissures of greater or less width are unavoidably formed between the gastight metal jacket of the nipple and the refractory lining. The invention is based likewise on the idea that, for practical purposes, it is by no means needful to provide a nipple affording an extremely tight seal. Rather, the purpose at hand will be adequately achieved if the nipple will permit only such a volume of gas leakage as will not substantially affect the final vacuum obtainable by the pump, nor impair the degassing effect by reaction with the melt.

On this basis, the invention consists in that, firstly, the gastight jacket of the nipple is completely enveloped by ceramic material at its orifice end, and in that, secondly, means are provided to oppose formation of cracks or fissures at the boundary surface between jacket and ceramic material.

The invention provides various means of diminishing, if not completely eliminating, leakage of gas along the said boundary surface. One of these means consists in that at least one annular metal disk is imbedded in the ceramic envelope of the jacket and joined in gastight man-

2

ner to the latter. Such a ring substantially reduces the likelihood of cracking, owing to the change in direction of the boundary surface. Several such rings will create so many interruptions that a continuous fissure from top to bottom becomes impossible, so that the path of leakage will in very large part be confined to pores in the ceramic material. Any continuous cracking between the rings and the ceramic material is in general unlikely. But even if it occurs, the plurality of annular disks will give the effect of a labyrinth seal, with at least intervals of strict porosity leakage, which reduces the volume of penetrating gas to insignificance.

According to the invention, another means of diminishing gas leakage due to cracking along the surface of the jacket consists in the use of layer of fine powder in contact with the outer surface of the jacket and accommodated by an annular space enclosed from without by the ceramic material on the immersion end of the nipple. Deformations due to thermal stresses, which are the chief cause of splitting between jacket and ceramic material, are deprived of their harmful effect by this means for the powder, which by reason of its fineness has an extremely slight gas penetrability, will fill every crevice or cavity formed on the outer surface of the jacket through deformation, by pouring into it promptly.

If it is important, in a particular case, to exclude any transit of oxygen from the air into the vacuum vessel, then this can be accomplished, with a nipple according to the invention, by introducing an inert gas, for example nitrogen, into the ceramic material.

The device according to the invention will now be more fully described with reference to the accompanying drawing, but it should be understood that this is given by way of illustration and not of limitation and that many changes may be made in the details without departing from the spirit of the invention.

In the drawing,

FIG. 1 shows a sectional view of a vacuum vessel for degassing steel, dipping into a ladle of molten metal;

FIG. 2 shows a longitudinal section of the immersion end of a nipple according to one embodiment of the invention; and

FIG. 3 shows a similar view according to another embodiment.

In FIG. 1, 10 is the evacuable chamber of a degassing vessel consisting of an outer metal jacket 11 and a refractory lining 12 of ceramic material. A vacuum pump, not shown, is connected by a line 13 to an aperture 14 opening into the chamber 10. The chamber 10 may be heated. Means required for this are not shown. On the underside, the degassing vessel terminates in a nipple 15 consisting of a cylindrical steel jacket 16, a refractory inner lining 17, and a refractory envelope 18, extending over a portion of its length, of ceramic material. Its lower tip 19 is completely inclosed by the ceramic envelope. The nipple 15 dips into a ladle 20, structural details of which are not shown.

When the vessel is used to degas steel, the nipple 15 is immersed in molten steel 21 contained in the ladle 20. Then if the chamber 10 is evacuated, the molten steel will rise through the nipple into the vessel, as indicated in the drawing.

Heretofore, it has been supposed that a nipple as drawn in FIG. 1 would not permit maintenance of the necessary vacuum, in particular a minimal oxygen partial pressure, in the chamber 10, because air would enter the ceramic mass at the surface parts 22 exposed to the atmosphere and leak through it as indicated by the arrows in FIG. 1 to flow into the chamber 10. Attempts were accordingly made, as described above, to erect a barrier, for example by extending the jacket 16 all the way to the face 23. The fact that this, owing to direct contact

between the metal jacket 16 and the molten metal 21, presented formidable problems is obvious.

As was first learned through the efforts on which the invention is based, the air current set up by the vacuum in chamber 10 does not travel, except for an insignificant fraction, as indicated by the arrows in FIG. 1. For the most part, that current of air follows the aforesaid fissures unavoidably formed between the jacket 16 and the ceramic masses 17, 18 adjoining it internally and externally. Hence the air enters almost exclusively at point 24 into the crack between the outer surface of the jacket 16 and the ceramic mass, travels down that crack to the tip 19 and then up the crack between the inner surface of the jacket and the ceramic mass, and passes into chamber 10 through the pores in the ceramic material, which though small are very numerous over the considerable surface area there available.

The essential parts of the nipples of FIGS. 2 and 3 are the same as in FIG. 1. In particular, the tip 19' of the jacket 16 is completely imbedded in the ceramic mass 17', 18'.

In the embodiment of the invention according to FIG. 2, several annular disks 25 are welded to the jacket 16'. The drawing shows seven such rings. In cases where requirements are not exacting, a single ring may suffice. In general, however, a plurality of rings will be provided, particularly as a better support for the ceramic layer 18' enveloping the jacket is thereby afforded.

Each ring 25, where it is joined to the jacket 16', represents a multiple change in direction of the boundary surface between the jacket 16' and the ceramic layer 18'. With several such interruptions, a crack or fissure such as may occur at 26 loses its significance as a passage for air leakage.

Formation of cracks between the ceramic mass and the outer surfaces of a ring 25 has been found empirically to be unlikely. But even in the unusual case where such cracks occur locally on the rings and along the jacket 16', incoming air is opposed by high resistance to flow.

It is advisable for the several rings 25 to have unlike outside diameters. Further, such rings may be welded only to the inner surface of the jacket 16', or provided both inside and out.

In the embodiment of FIG. 3, a recess between the outer surface of jacket 16'' and the ceramic layer 18'' enveloping the nipple at its immersion end provides a cylindrical annular space 27, which is filled with fine powder. If, for example, the refractory layer 18'' consists of Korunite, finely ground corundum (powdered corundum) may preferably be used. However, other kinds of powdered refractory material may alternatively be employed, provided they contain an adequate proportion of fine material and the relative mobility of the individual grains is preserved in service. This powder per se, owing to its fineness, presents a very considerable resistance to flow of air leakage, substantially surpassing that of the ceramic mass. At the same time, formation of gaps along the outer surface of the jacket 16'' is excluded since in the event of deformations, the charge of powder will slip in and automatically repair any cavities. For a mechanically stable connection between the layer 18'' and the jacket 16'', steel stirrups 28 are welded to the jacket and anchored in the envelope.

For the reasons stated in the preamble, it may be necessary to prevent any entry of oxygen from the air into the chamber 10. This can be accomplished by subjecting the entire porous ceramic mass to pressure of an inert gas, say nitrogen. For this purpose, in FIG. 2, a ring nozzle 29 with perforated wall is imbedded in the layer 18, opening to the outside through a connection 30 leading to a source of nitrogen. The gas pressure at 30 is so proportioned that wherever layer 18' makes contact with the air, nitrogen will pass from the inside out, rather than air from the outside in.

What we claim is:

1. In a degassing vessel adapted to receive molten metal from a melt containing ladle, in combination, a substantially enclosed evacuable metal container having a bottom portion with an opening formed therein, a metallic nipple affixed to said metal container and extending vertically downward from said opening, said nipple having an inner face, an outer face and a lower tip portion, an inner refractory lining abutting to the interior of said metal container and the inner face of said nipple, said inner refractory lining extending below said tip portion, an outer refractory lining abutting to the outer face of said nipple and extending below said tip portion, both said linings merging below said tip portion and enclosing the same, and a plurality of ring-like members extending from said nipple and having inner and outer edges, one of said edges being air-tightly secured to said nipple and the other edge of each of said ring-like members being completely embedded in said refractory material.

2. The device according to claim 1, further provided with means in said outer lining for introducing under pressure an inert gas into said outer and inner linings, adjacent said metal nipple.

3. In a degassing vessel, adapted to receive molten steel from a melt-containing ladle in combination, a substantially closed evacuable metal container having a bottom portion with an opening therein, a metal nipple contiguous with said metal container extending vertically downwardly from said opening and having an inner face, an outer face and a lower tip portion, an inner refractory lining of ceramic material on the inner face of said metal container and the inner face of said nipple, said inner refractory lining extending below said lower tip portion, an outer refractory lining surrounding the outer face of said nipple and at least partly spaced therefrom, said outer lining extending below said tip portion and merging with said inner lining, and a mobile layer of powdered refractory material interposed between said outer face of the nipple and said outer lining, and a plurality of members affixed at one end to said nipple and having their other ends anchored in said outer lining for providing a mechanically stable connection between said nipple and said outer lining.

4. The device claimed in claim 3, in which said ceramic material is a Korunite and the said powdered refractory material is a finely ground corundum.

5. In a degassing vessel adapted to receive molten metal from a melt-containing ladle, in combination, a substantially closed evacuable metal container having a bottom portion with an opening formed therein, a metal nipple affixed to said metal container and extending vertically downward from said opening, said nipple having an inner face, an outer face and a lower tip portion, a lining of refractory material on the inner face of said nipple, said inner refractory lining extending below the lower tip portion, a lining of refractory material on the outer face of said nipple and extending below said tip portion, both said linings merging below said tip portion and enclosing the same, and a plurality of ring-like members extending outwardly from said nipple and having inner and outer edges, the inner edge of each of said ring-like members being air-tightly secured to said outer face and the outer edge of each of said ring-like members being completely embedded in said outer refractory lining.

References Cited in the file of this patent

UNITED STATES PATENTS

2,688,682	Bell	Sept. 7, 1954
2,906,521	Harders	Sept. 29, 1959

FOREIGN PATENTS

736,852	Great Britain	Sept. 14, 1955
---------	---------------	----------------