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(54) Title: LIQUID METAL PUMP WITH ISOLATOR ASSEMBLY

(57) Abstract

In conjunction with a hot metal pump in a reactive metal bath, a novel isolator assembly (3, 35) is provided which reduces the tendency of the pump to impart turbulence to the melt thereby reducing reaction between the melt and the atmosphere and the production of dross. The isolator assembly comprises a housing (3, 35) positioned around the drive shaft (4, 32) of the pump.
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LIQUID METAL PUMP WITH ISOLATOR ASSEMBLY

Technical Field

The invention relates to the field of pumping molten metal and, in particular, to the pumping of molten metal which is reactive with the atmosphere. The invention is useful in those situations where it is not practical to replace the atmosphere with an inert gas.

In molten metal pumps of the type here improved, a displacement means (e.g., an impeller) is used below the surface of the liquid to force the molten metal up a riser tube to its destination. A motor is used to rotate the impeller. And because the motor is more efficiently located above the molten metal surface, an impeller shaft is used to communicate the rotational motion from the motor to the impeller. The impeller shaft therefore is part above and part below the molten metal surface. Typically, metal and dross tend to adhere to the impeller shaft at the surface which, when the shaft is rotated, causes a turbulence in the liquid. This turbulence was found to cause an increase in the rate of reaction between the metal and the atmosphere resulting in excessive dross formation or appearance of metal/gas complexes.

Summary

It is an object of the invention to reduce dross formation in reactive, molten metal systems.

More specifically, it is an object of the invention to reduce dross formation near a rotating or reciprocating shaft in a reactive, molten metal system.

In accordance with the objectives, the invention is an apparatus for pumping a reactive molten metal and a method for pumping reactive molten metal without a buildup of reaction products.
The apparatus comprises molten metal pumping means including displacement means, a rotating or reciprocating shaft for moving the displacement means, the means for driving the shaft, a fixed, protective housing surrounding the shaft in the region of the molten metal surface and means for admitting molten metal to the space between the protective housing and the shaft. Preferably, the apparatus also includes means for raising the gas pressure in the space between the shaft and the protective housing to lower the metal level therein.

The inventive method of reducing reaction near moving shafts in reactive molten metal baths comprises fixing a protective housing around the shaft and allowing molten metal to enter the space between the protective housing and the shaft. Preferably the method also comprises applying a gas pressure to the space between the housing and the shaft to lower the metal level therein.

**Brief Description of the Drawing**

Figure 1 and Figure 2 are sectional elevation views of the inventive apparatus taken along planes perpendicular to each other.

Figure 3 is a sectional view of the apparatus of Figure 1.

Figure 4 is a breakaway of alternative reciprocating apparatus according to the invention.

**Description of the Preferred Embodiments**

An impeller-type embodiment pump apparatus is shown in Figures 1-3. The apparatus basically consists of three columns. One column contains the impeller 20, impeller shaft 4 and motor 21. The second column is a pump riser 5 for moving molten metal from the impeller to the top of the pump and the third column is merely a support post 6.
The apparatus shown is a centrifugal pump having an impeller 20 supported and rotated directly by impeller shaft 4. The impeller shaft is in turn rotated by motor shaft 21 through an intermediate series of couplings. In particular, the shaft of motor 21 is pinned to motor coupling 10 which is pinned to connecting shaft 12. Connecting shaft 12 is pinned to a universal joint 16 which supports the impeller shaft 4 through an impeller nipple 11. The connecting shaft 12 is rotatably located within bushing 14 and bearing housing 8 and is sealed with seal 15 and seal retainer 9. Housing 8 rests on a pump support plate 2.

Pump riser 5 has a channel 23 communicating with the impeller 20 through passage 24. Riser reducer 13 and riser tube 25 are connected at the top of the channel 23. Mounting sleeves 1 fix the pump riser 5 and the support post 6 to the pump support plate 2.

The bottom of pump riser 5 and the support post 6 are fixed in a lower support block 17. Impeller 20 is rotatable within the lower support block or pump housing 17 against bearing ring or rubbing seals 26.

The isolator assembly comprises a nonrotatable protective housing 3 fixed to the pump support plate 2 through a mounting sleeve 7. The protective housing is open at the bottom such that molten metal can enter the space between the isolator housing and the impeller shaft. An orifice 22 in the bearing housing (or optionally located through the pump support plate) is in gas communication with the space between the isolator housing and the impeller such that an inert gas may be forced therein to lower the level of molten metal in the space.

The impeller is a cylindrical member with holes 27 in the periphery. The molten metal enters the impeller through the open bottom along the rotational axis and is forced at about 10 psig through the holes, into passage 24 and up the riser channel 23 and riser tube 25. Some metal
is also forced upwardly between the impeller and the seals.

Any reactive metals can utilize the invention. Iron, magnesium, aluminum, copper, lead, zinc and alloys thereof are examples, though many others exist. Lower melting metals and alloys may utilize the inventive pumping apparatus made of steel parts. Lower melting metals or alloys which attack steel and the higher melting metals or alloys may utilize a pumping apparatus made of graphite parts below the level of the melt. For example, a steel pump according to the invention could be used with lead or zinc. However, a pump with graphite parts below the surface should be used with aluminum because aluminum attacks most steels. The rubbing seals in either case most effectively should be silicon carbide or equally hard material. The upper couplings can be made of metal.

Although somewhat effective by itself in preventing the large buildup of reaction products, the open-ended, nonrotatable protective housing is preferably pressurized to lower the melt level. Without an overpressure, the level inside would, of course, be substantially equal to the level of the bath. An overpressure equal to the metallostatic head pressure of the melt in the annular space between the isolator housing and the shaft would lower the level to the bottom of the isolator housing. A pressure of about 1-2 psig is typical with light metals. Argon or other nonreactive gas is desirable. Preferably, the level of the melt inside the space is just above the bottom of the isolator housing.

The displacement means for moving molten metal up the riser can be a rotatable impeller, as shown, or could be a positive displacement piston-type element which would require a reciprocating action by the piston and shaft to pump the metal. The latter are shown in Figure 4. The piston 31 is shown on shaft 32 and is guided into pump housing 33 by guide plate 34. The piston and shaft
are enclosed by protective housing 35 joined to the pump housing at the lower end. Protective housing has an orifice 36 for admitting molten metal in the space between the shaft and protective housing and into the chamber 37 through channel 38 on the upstroke. On the downstroke, piston 31 is sealed against the pump housing with seal 39 and molten metal is pumped out of the chamber 37 through hole 40 to a riser (not shown).

When the protective housing is extended to the lower support block or pump housing 17 of the centrifugal pump shown in Figure 1, the molten metal may enter the space between the protective housing and the shaft through the gap between the impeller and the lower support block. The seals are not adequate at the operating pressure to prevent such occurrence.
We Claim:

1. Apparatus for pumping molten metal from a melt pool to a point outside the melt pool which comprises
   (A) rotatable or reciprocable displacement means in the melt pool for displacing a portion of the melt,
   (B) means for receiving displaced molten metal from the displacement means and conveying it to the point outside the melt pool,
   (C) means above the melt pool for rotating or reciprocating the displacement means,
   (D) a rotatable or reciprocable shaft communicating the displacement means with the means for rotation or reciprocation,
   (E) a fixed protective housing positioned around the shaft at the melt pool surface such that a space is formed therebetween, and
   (F) means for admitting molten metal into the space between the fixed protective housing and the shaft.

2. The apparatus of Claim 1 wherein the displacement means is a rotatable impeller and the shaft is rotatable.

3. The apparatus of Claim 1 wherein the displacement means is a piston and the shaft is reciprocable.

4. The apparatus of Claim 1 wherein the fixed protective housing is open to the melt pool at its lower end such that metal may flow directly into the space between the protective housing and the shaft.
5. The apparatus of Claim 4 which further comprises means for applying a positive gas pressure within the space between the protective housing and the shaft to lower the level of molten metal therein.

6. The apparatus of Claim 1 which further comprises a fixed pump housing around the displacement means and wherein the protective housing is fixed at its lower end to the pump housing.

7. The apparatus of Claim 6 wherein the means for admitting molten metal into the space between the protective housing and the shaft comprises an orifice in the protective housing.

8. Method for reducing reactions with the atmosphere near rotatable or reciprocating shafts in molten metal pools comprising fixing a nonrotatable, non-reciprocatable protective housing around the shaft, and thereby forming a space between the protective housing and the shaft, and allowing the molten metal to enter the space between the protective housing and the shaft.

9. The method of Claim 8 wherein the protective housing is open at its lower end and which further comprises applying a positive gas pressure within the space between the protective housing and the shaft to lower the level of molten metal therein.
**INTERNATIONAL SEARCH REPORT**

International Application No PCT/US 85/00845

**I. CLASSIFICATION OF SUBJECT MATTER**

If several classification symbols apply, indicate all.

According to International Patent Classification (IPC) or to both National Classification and IPC

**IPC**: F 04 D 7/06; F 04 B 15/04; B 22 D 39/00

**II. FIELDS SEARCHED**

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**IV. CERTIFICATION**

Date of the Actual Completion of the International Search: 14th August 1985

Date of Mailing of this International Search Report: 03 SEP. 1985

International Searching Authority: EUROPEAN PATENT OFFICE

Signature of Authorized Officer: G.L.M. Kuippenberg

Form PCT/ISA/210 (second sheet) (January 1985)
ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 85/00845 (SA 9602)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 27/08/85.

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For more details about this annex:
see Official Journal of the European Patent Office, No. 12/82