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(54) Molten metal detection sensor.

(57) A molten metal detection sensor provided with hermetically sealing means for sealing an internal space of the sensor. The molten metal detection sensor includes a hollow holder (3) assembled in a metal mold, an electrode rod (1) extending through the holder (3) and an insulator (2) interposed between the electrode rod (1) and the holder (3) at one end portion of the holder (3) confronting a molten metal path. A rear open end of the holder (3) is attached with a lid member (15) for hermetically confining an internal space of the holder (3), and a filling material is filled in the internal space. One end portion of a lead wire (9) is connected to the electrode rod (1) for transmitting a molten metal detection signal to an external device. The lead wire extends through a wall of the holder (3) at a penetrating portion (14) where a tubular member (17a) is provided to surround the lead wire (9). The tubular member (17a) is engageable with the wall of the holder (3), and a top end of the tubular member is sealed by a sealing means (18).

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The present invention relates to a molten metal detection sensor for use in an injection molding apparatus which produces a die-casting product, and more particularly to a type thereof in which an insulation treatment is effected to a wire leading portion for stabilizing a quality and improving durability.

For production of a die-casting product, a gas vent valve is provided in a metal mold in order to eliminate gas involvement within the casted product. The gas vent valve must be opened until the molten metal is filled at a predetermined position in the metal mold, and must be closed when the molten metal is elevated to the predetermined position in the metal mold. In the production of the die-casting product, in order to properly operate the gas vent valve, a molten metal detection sensor is disposed at a runner portion, a mold cavity portion or a gas vent passage in the metal mold of the die-casting machine so as to detect a reaching position of the molten metal within the metal mold.

One example of a conventional molten metal detection sensor is disclosed in DE 3,912,006A published on November 30, 1989. As shown in Fig. 2, the disclosed molten metal detection sensor includes an electrode rod 101, an insulator 102 for supporting the electrode rod, a holder 103 which constitutes a main body portion of the sensor, and a wire 109 connected to the electrode rod 101.

The molten metal detection sensor electrically detects the molten metal formed of an electrically conductive material by a contact of the molten metal with a tip end of the electrode rod 101, and transmits a molten metal detection signal through the wire 109 to an external device such as a control means for generating gas vent valve closing signal. To this effect, the electrode rod 101 must be insulated from a body of the holder 103 etc. Thus, the electrode rod 101 is electrically insulatingly supported by the holder 103 by means of the insulator 102 and an insulation washer 105.

However, according to the above described molten metal detection sensor, a rear side of the sensor and leading out portion of the wire 109 are not sealed, so that water, oil etc. may be entered into an interior of the molten metal detection sensor through these portions. Further, since the temperature of the metal mold is remarkably changed, the temperature of the molten metal detection sensor which is connected to the metal mold is also changed excessively, and as a result, a water content of the air which has been entered into the sensor may be condensed to generate a water droplet or dew. If water or oil etc. is entered into the holder 103, insufficient insulation may occur such that electrically conducting state may be provided regardless of the contact of the molten metal with the electrode rod. As a result, a signal may be flowed which may be indicative of the arrival of the molten metal to the position of the molten metal detection sensor despite of the fact that the sensor does not actually detect the molten metal, i.e, the molten metal does not reach the electrode rod. Thus, erroneous operation occurs with respect to the gas vent valve, that is, the gas vent valve may be erroneously closed, which in turn causes insufficient gas venting operation to provide gas involvement within the die-casting product.

Further, in order to eliminate this problem, frequent inspection or replacement to the molten metal detection sensor must be required. Furthermore, service life of the molten metal detection sensor may be reduced due to the entered water or oil.

The present invention has been established in view of the above-described problems, and therefore, it is an object of the present invention to provide a molten metal detection sensor in which avoidable is erroneous operation of the gas vent valve due to the entry of the water and oil into an interior of the sensor, and capable of providing a prolonged service life.

This and other objects of the invention will be attained in the present invention by providing a molten metal detection sensor including a holder assembled to a metal mold for use in a die-casting; an electrode rod supported in the holder and having a tip end contactable with a molten metal flowing within the metal mold; a lead wire having one end connected to a rear portion of the electrode rod and penetrating through the holder to be connected to an external device; and an insulation member disposed for electrically insulating the electrode rod from the metal mold, a molten metal detection signal being transmitted from the electrode rod to the external device through the lead wire upon contact of the molten metal to the electrode rod, characterized in that a rear end portion of the holder is hermetically sealed by a lid; and in that a tubular member is disposed at the lead wire penetrating portion of the holder for surrounding the lead wire; and in that an upper portion of the tubular member is sealed by a sealing member.

According to the molten metal detection sensor thus constructed in the present invention, the rear portion of the sensor is hermetically provided, and a leading out portion of the wire is disposed within a tubular member. Therefore, entry of water, oil, etc into an interior of the sensor through these portion can be avoided, and therefore, insufficient insulation can be obviated, to thereby remarkably enhance reliability and durability of the sensor.

In the drawings;

Fig. 1 is a cross-sectional view showing a molten metal detection sensor according to one embodiment of this invention; and

Fig. 2 is a cross-sectional view showing a conventional molten metal detection sensor.

A molten metal detection sensor according to one embodiment of this invention will be described with reference to Fig. 1. The molten metal detection sensor includes an electrode rod 1, a sleeve like metal holder

3 for supporting the electrode rod 1, an insulator 2 for insulating the electrode rod 1 from the metal holder 3 and a lead wire 9 connected to a rear end portion of the electrode rod 1. The molten metal detection sensor of the present embodiment is disposed at a gas vent passage (not shown) within a metal mold (not shown). Incidentally, the position of the molten metal detection sensor is not limited to the gas vent passage, but the sensor can be positioned on a runner portion or a mold cavity within the metal mold.

At one end portion, i.e., at the molten metal detecting side of the holder 3, a front recessed hole 3a is formed, and another end of the holder is formed with a rear recessed hole 3b. Further, a communication hole 3c is formed to communicate the front and rear recessed holes 3a and 3b. The electrode rod 1 extends through the front recessed hole 3a, the communication hole 3c and the rear recessed hole 3b. The insulator 2 is fully made up of an insulating material separate from the holder 3. However, a separate ferrous member coated with the insulating material is also available. Alternatively, the insulator 2 can be provided integrally with the holder 3, and an insulation material is coated on a contacting portion between the electrode rod 1 and the holder 3. The insulator 2 is made of a material having corrosion resistance, thermal resistance and insulative characteristic against the molten metal. For example, a ceramic material such as Alumina, silicon nitride, Sialon and Silica is available.

Within the recessed hole 3a, the hollow cylindrical insulator 2 is provided for electrically insulating the electrode rod 1 from the holder 3. The insulator 2 has a center portion formed with a center bore 2a to allow the electrode rod 1 to pass therethrough. Further, a tapered surface 2b whose diameter is gradually increased toward a gas vent passage is formed at the molten metal detection side of the insulator 2.

Thus, the electrode rod 1 is inserted through the insulator 2 provided in the front recessed hole 3a, the communication hole 3c, and the rear recessed hole 3b of the holder 3. The electrode rod 1 includes a shaft portion 1a, a head portion 1b provided at a front tip portion of the shaft portion 1a and a thread portion 1e provided at a rearend portion of the shaft portion 1a. The head portion 1b extends into the gas vent passage, and has an outer diameter larger than that of the shaft portion 1a. The head portion 1b has a tapered head surface 1c engageable with the tapered surface 2b of the insulator 2 and a detecting portion 1d for detecting the molten metal.

The electrode rod 1 is made of a material having corrosion resistance against the molten metal and sufficient electrical conductivity. The material also provide a chemical property in which an oxide film is hardly formable on a surface thereof. For example, a die steel, stainless steel, Stellite, electrically conductive Sialon, titanium nitride, titanium carbide, or those material undergoing surface treatment with Ti, N, Tic and CN would be preferable.

An inner diameter D of the center bore 2a of the insulator 2 is made larger than an outer diameter d of the shaft portion 1a of the electrode rod 1 by a predetermined dimension. As a result, an annular space 4 having a distance of (D-d)/2 is provided between the center bore 2a and the shaft portion 1a of the electrode rod 1. This width of the space 4 is provided so as to avoid contact of the electrode rod 1 with the center bore 2a of the insulator 2 even if the electrode rod 1 is thermally expanded due to the contact with the heated molten metal.

The thread portion 1e of the electrode rod 1 is attached with an electrode holding member H for urging the tapered head surface 1c of the head portion 1b of the electrode rod 1 toward the tapered surface 2b of the insulator 2 in order to provide an intimate contact therebetween and to avoid entry of the molten metal into the holder 3.

The electrode rod holding member H includes an insulation washer 5 in contact with a bottom wall of the rear recessed hole 3b of the holder 3, a spring washer 6, a fastening nut 7 for depressing the insulation washer 5 through the spring washer 6, and a wire fixing nut 8 threadingly engaged with the thread portion 1e at a position behind the fastening nut 7. The insulation washer 5 is adapted for insulating the shaft portion 1a of the electrode rod 1 from the holder 3. The spring washer 6 is adapted to urge the electrode rod 1 rearwardly (leftwardly in Fig. 1, i.e., direction opposite the molten metal detecting side), so as to provide intimate contact of the tapered head surface 1c of the electrode rod 1 with the tapered surface 2b of the insulator 2 because of the biasing force of the spring washer, to thus avoid entry of the molten metal into the interior of the holder 3. The insulation washer 5 is made of a material having corrosion resistance, thermal resistance and insulative characteristic against the molten metal. For example, a ceramic material such as Alumina, silicon nitride, Sialon and Silica is available.

A wire 9 for externally transmitting an electrical signal from the detection rod 1 is connected to the thread portion 1e of the electrode rod 1 at a position between the fastening nut 7 and the wire fixing nut 8. The wire 9 can be securely connected and fixed to the electrode rod 1 by means of the relative clamping force provided by the fastening nut 7 and the wire fixing nut 8. Incidentally, an insulation layer of a tip end portion of the wire 9 is peeled off for electrical connection to the wire fixing nut 8. Of course, another end of the wire is connected to a control means (not shown) so as to send the molten metal detection signal thereto. In response to the signal the control means generates a drive signal for actuating a gas vent valve driving mechanism such as an electromagnetic valve in order to close the gas vent valve in response to the

molten metal detection signal.

A lid member 15 is fixedly secured to a rear end face 3e of the holder 3 by a bolt 16 in order to cover a rear open end of the recessed hole 3b. Therefore, an internal space 19 of the recessed hole 3b is sealingly maintained by the lid member 15. Further, a silicone rubber foaming material is filled in the internal space 19 as a filler. Two-part type silicone rubber foaming material may be available. In this case, a sealing layer may be provided between the lid member 15 and the rear end face 3e of the holder 3. However, the filler is preferable so as to occupy the space, otherwise dew condensation may occur in case of the existence of the space.

The reason for employment of the silicone rubber foaming material as the filler in the space 19 is as follows: (1) The silicone rubber foaming material has sufficient thermal resistance (sustainable against an operating temperature of not less than about 200°C). Therefore, the material is suitable as the filler to be filled in the internal space of the molten metal detection sensor which has relatively high temperature. (2) The volume of the material is several times as large as the initial volume thereof after foaming. Thus, the internal space is sufficiently filled with the material, which is advantageous as the filler. (3) Prior to the foaming, the material is of liquid state. Therefore, the internal space of the molten metal detection sensor can be easily filled with the material which is advantageous in terms of workability. (4) After foaming, the material becomes solid state. Therefore, disassembly of the molten metal detection sensor can be facilitated because of the easy removal of the material. (5) The volume of the material becomes several times as large as the initial volume when foaming. Therefore, air in the molten metal detection sensor can be discharged out of the sensor at the time of foaming, and even if residual air exists in the internal space, the volume of the air may be reduced because of the application of pressure upon foaming, to thereby reduce probability of dew condensation. Incidentally, in the depicted embodiment, the silicone rubber foaming material is used as the filling material. However, varnish, polyimide resin, heat resistive inorganic adhesive agent, heat resistive paint, and silicone sealing material (heat resistant sealing material) are also available.

Further, a female thread 14a is formed at a rear upper portion or wire leading out portion 14 of the holder 3 for leading out the wire 9, and a tubular member is attached to the wire leading out portion. The tubular member includes a copper pipe 17b and a steel pipe 17a fixed thereto by brazing. The steel pipe 17a has an outer peripheral surface formed with a male thread engageable with the female thread 14a. Within the steel pipe 17a and the copper pipe 17b, the wire 9 extends, which is connected and fixed to the electrode rod 1. A space is defined between the wire 9 and the copper pipe 17b. This space is sealed by a silicone adhesive tape 18 at an upper position of the copper pipe 17b. As a result, internal space of the holder 3 maintains approximately hermetically sealed state. an insulating tube 20 such as a Teflon tube or a silicone tube is disposed within the steel pipe for surrounding the lead wire 9. This insulating tube 20 can provide electrically insulating state between the steel pipe 17a and the tip end portion of the wire 9 where the insulative coating is peeled off.

In the above described embodiment, the space between the wire and the steel pipe is sealed by the silicone adhesive tape. However, the sealing material is not limited thereto, but other member such as an insulation tube and shrinkable tape is available. Further, in the above described embodiment, the copper pipe brazed with the steel pipe is used as the tubular member provided at the wire leading out portion of the holder. However, this portion can be formed by the steel pipe only, and other metallic pipe such as a stainless steel pipe and aluminum pipe or heat resistant resin pipe are also available. Furthermore, a screw member such as a hollow hexagonal bolt is also available as the tubular member.

According to the present invention described above, the rear open end of the holder of the molten metal sensor is provided with the lid member, and the tubular member is provided at the wire leading out portion of the holder and the space between the tubular member and the wire is sealed by the sealant. Therefore, entry of water or oil into the internal space of the holder can be eliminated. As a result, no insufficient insulation is provided, to thereby enhance reliability and durability of the molten metal detection sensor. Further, erroneous operation of the sensor can be avoided due to the insufficient insulation in the inside of the molten metal sensor. Therefore, the gas vent valve which is operated in response to the signal from the sensor can be properly operated, to thus attain a production of high quality die-casting product without any air involvement therein. Moreover, by filling the filling material within the holder, air within the holder can be expelled therefrom. Accordingly, avoidable is insufficient insulation due to dew condensation within the holder.

Claims

1. A molten metal detection sensor including a holder having a rear open end and assembled to a metal mold for use in a die-casting; an electrode rod supported in the holder and having a tip end contactable with a molten metal flowing within the metal mold; a lead wire having one end connected to a rear portion of the electrode rod and penetrating through the holder to be connected to an external device; and an insulation member dis-

posed for electrically insulating the electrode rod from the metal mold, a molten metal detection signal being transmitted from the electrode rod to the external device through the lead wire upon contact of the molten metal to the electrode rod,

characterized in that the rear open end portion of the holder (3) is hermetically sealed by a lid means (15);

in that a tubular member (17a,17b) is disposed at the lead wire penetrating portion (14) of the holder for surrounding the lead wire (9);

and in that an upper portion of the tubular member (17b) is sealed by a sealing member (18).

2. A molten metal detection sensor according to claim 1, characterized in that a filler is filled in an internal holder space (19) defined by the lid means (15) and an inner peripheral surface of the holder (3) for avoiding existence in air in the internal holder space.

3. A molten metal detection sensor according to claim 2, characterized in that the filler comprises a silicone rubber foaming material.

4. A molten metal detection sensor according to any one of the preceding claims characterized in that the sealing member (18) comprises a silicone adhesive tape which closes an upper open end portion of the tubular member (17b).

5. A molten metal detection sensor according to any one of preceding claims, characterized in that the lead wire penetrating portion (14) comprises a holder wall formed with a female thread (14a), and in that the tubular member comprises a metallic tube formed with a male thread engageable with a female thread (14a), the lead wire insulatingly extending through the tubular member.

6. A molten metal detection sensor according to claim 5, further comprising a tubular insulating member disposed within the tubular member and positioned to surround the lead wire.

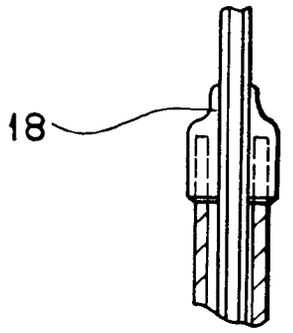

FIG. 1

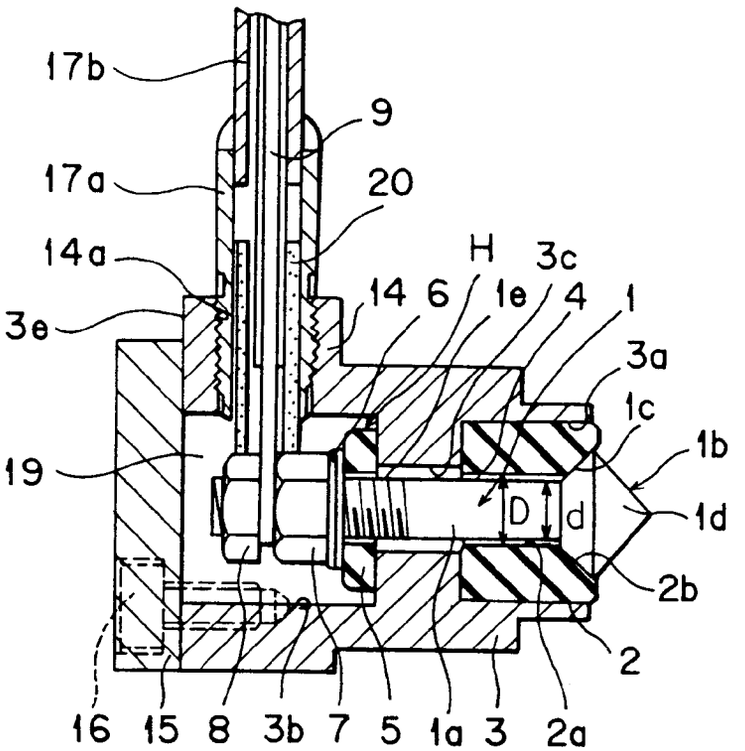

FIG. 2
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