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LINING FOR MOLTEN METAL CONTAINERS

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The invention relates to melting pots, holding furnaces, or other receptacles for melting, or holding in the molten state, aluminum or aluminum base alloys. It relates more specifically to a pot-wash or lining wherewith the interior of the said receptacles may be coated, thereby effecting a substantial improvement in the physical characteristics of the metal contained therein.

In the art of melting, holding, and casting metals and alloys the practice of coating the interior of melting pots, holding pots, and even molds, with various types of pot-washes and mold-washes is well known. Such coating material serves several purposes, including the protection of the pot or container from erosion or other attack by the molten metal and the protection of the molten metal from contamination by material dissolved from the container itself. The coating should be reasonably adherent, so as not to require too frequent renewals, and should be practically inert as regards both the molten metal and the container.

Molten aluminum and aluminum base alloys have a tendency to sorb certain gases with which the molten metal comes into contact. A certain proportion of the sorbed gas is released upon solidification of the metal and quite frequently is trapped within the casting, in bubbles of greater or less extent, so as to cause unsoundness and local discontinuities which result in a general weakening of the structure, and perhaps failure under stress. The presence of this type of porosity is often detectable by X-ray examination of the casting but is sometimes discovered only after failure of the casting. The same condition also unfavorably affects the working characteristics of ingots and billets made of alloys intended to be wrought. Even if discovered before failure the casting must be scrapped, with resulting financial loss.

The presence of gas porosity which is so minute as not to be otherwise easily detectable may show itself by the development of blisters on the surface of billets, sheets, or wrought articles which have been annealed above about 260° C. As a matter of fact, sensitive tests to determine the presence of gas in the solid metal are based on this manifestation. Blisters on a product usually spoil its appearance and result in its rejection. Rejections of this nature increase the cost of production and must ultimately be paid for by the consumer. For the foregoing and other reasons it is very desirable that a convenient method be devised for freeing the molten aluminum alloys from dissolved gases.

A very common method of degassing heretofore employed consists in the use of a flux. Fluxing is generally accomplished by introducing certain reagents into the molten metal, allowing any residue to accumulate in a crust or skin at the surface, and removing this residue before pouring. Other methods are also known, such as melting or holding the molten metal in a vacuum so as to either prevent the dissolving of harmful gases or to favor their release by the melt. All such methods must be applied to every heat of metal, and are generally cumbersome and expensive. Furthermore, these methods cannot always be safely applied to certain alloys because of injurious effects, such as the tendency to remove a constituent from the alloy.

One of the objects of my invention is to effect a reduction in the gas content of aluminum and its alloys without the necessity of introducing any substance in the metal during the melting or casting operation.

Another object is to avoid the use of any additional equipment in the foundry or necessitate any change in the customary foundry practice.

I have discovered that gases present in molten aluminum and its alloys may be entirely or almost entirely removed by melting or holding the molten metal in a pot or receptacle which has been lined with a mixture of cryolite and a binder. The mixture should contain from about 30 to 70 per cent cryolite by weight. Cryolite is a double fluoride of sodium and aluminum which is commercially available. Either the natural or synthetic variety of cryolite should be made up into a paste with water and a suitable binder such as lime, fireclay, silica, magnesia, alumina, "red mud" residue obtained from purification of bauxite, or sodium silicate. The cryolite in powdered form and the binder, when made up into a paste of the proper consistency, is applied to the interior of the receptacle for the molten metal and forms an adherent coating thereon. The coated container may then be heated to an elevated temperature after air drying so as to cause the coating or lining to harden. The pot may be used repeatedly over an extended period of time and it is not necessary to re-line the interior with a fresh coat any oftener than has been the case with former pot washes not containing cryolite. The lining, in fact, has been found to lengthen the life of a pot in service.

As a preferred embodiment of my invention which is particularly applicable to coating iron pots, I use a mixture of equal parts by volume of powdered cryolite and the aqueous solution

of sodium silicate known commercially as water glass. This aqueous solution is more economical to use, and it produces a more satisfactory coating than where the dry sodium silicate is added directly to the water or previously prepared paste of cryolite. The powdered cryolite should be added to the water glass solution and stirred in to form a paste of uniform consistency. This paste may be spread on the interior of the pot by a brush or other means and baked on as described above. For coating the interior of plumbago or clay crucible I prefer to use a mixture of equal parts of lime and cryolite since I have found this to be somewhat more adherent than mixture of cryolite and water glass.

I have made a number of comparative tests to determine the effect of this cryolite-bearing coating on the gas content of molten aluminum and its alloys. An aggravated gas condition was induced by bubbling hydrogen gas through a heat of molten aluminum in two separate pots, one pot being treated with cryolite as above described, and the other pot not being coated. The metal in the cryolite-lined pot when cast showed no evidence of gassing, while the metal which was held in the unlined pot retained a very injurious amount of gas in the solidified metal. I have carried on a number of such tests using a variety of coating materials as a carrier for the cryolite and have invariably found that the presence of the cryolite in the lining either entirely removes dissolved gas from the molten metal or greatly improves the condition. Certain alloys such as those containing magnesium require a longer holding period in the lined pots. The proper holding time for any particular alloy can, of course, be easily determined by experiment.

The degassing action of the lining is accelerated as the temperature of the melt is increased. This is most fortunate since the sorption of gas by a molten metal increases with the temperature. In the use of receptacles coated with a cryolite-bearing material it is therefore unnecessary to restrict the temperature for fear of rendering the lining inoperative as a degassing agent. The pot or furnace may be handled and treated in the usual manner with respect to temperature control.

Since cryolite forms merely a mechanical mixture with the carrier, the relative proportion of each is not critical and the user may readily determine for himself what proportions give the most suitable mixture for ready application to the pot. In general from about 30 to 70 per cent cryolite should be employed in the mixture. Less than 30 per cent is insufficient to promote a rapid reaction, and more than 70 per cent interferes with the adhesion of the coating to the metal container.

Heretofore when various fluxes have been used as degassing agents they have been subject to the disadvantage that particles of the flux may be retained in the molten metal and transferred into the casting where their presence may frequently cause local weakness or failure. However, the cryolite-containing coatings made in

accordance with my invention and properly applied, are very adherent and do not readily chip off and thus do not introduce foreign particles into the metal. Certain fluxes also have an injurious effect on the melting or holding pot and, even when not otherwise harmful, the manipulations required in properly using and removing a fluxing material and its by-products constitute a foundry problem. On the other hand, the coatings described hereinabove do not attack the metal-holding containers or shorten the period of their usefulness; instead, the cryolite linings actually lengthen the life of the container. As the coatings become worn in time, they can be easily renewed by the application of another lining on top of the first one, or if desired, the original coating may be removed and a fresh one applied.

I claim:

1. A method of removing gas from molten aluminum and its alloys comprising holding the molten metal in a container coated on its interior with a lining containing cryolite and a binding agent.

2. A method of removing gas from molten aluminum and its alloys comprising melting the molten metal in a container coated on its interior with a lining containing from about 30 to 70 per cent by weight of cryolite and a binding agent.

3. A method of removing gas from molten aluminum and its alloys comprising holding the molten metal in a container coated on its interior with a lining containing cryolite and sodium silicate.

4. A method of removing gas from molten aluminum and its alloys comprising holding the molten metal in a container coated on its interior with a lining containing cryolite and lime.

5. A method of removing gas from molten aluminum and its alloys comprising holding the molten metal in a container coated on its interior with a lining containing cryolite and fireclay.

6. A coating material for application to the interior of a container for molten aluminum and its alloys said coating material containing from about 30 to 70 per cent by weight of cryolite and a binding agent.

7. A coating material for application to the interior of a container for molten aluminum and its alloys said coating material containing from about 30 to 70 per cent of cryolite and sodium silicate.

8. A coating material for application to the interior of a container for molten aluminum and its alloys containing equal parts by volume of powdered cryolite and a commercial aqueous solution of sodium silicate.

9. A coating material for application to the interior of a container for molten aluminum and its alloys said coating material containing from about 30 to 70 per cent of cryolite and lime.

10. A coating material for application to the interior of a container for molten aluminum and its alloys said coating material containing from about 30 to 70 per cent of cryolite and fireclay.

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