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REFINING BERYLLIUM IN THE PRESENCE OF A FLUX

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2 Claims. (Cl. 22—200)

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The present invention is concerned with the refining and casting of beryllium metal using a new and novel refining flux composition.

An object of this invention is to produce beryllium metal castings of substantially 99 per cent or higher chemical purity which are sound in structure and practically free of occluded gases.

Another object of this invention is directed toward a composition of a refining flux for melting and casting beryllium metal wherein said refining flux contains mixed compositions of beryllium, barium, calcium and lithium halides.

A further object of the invention is directed toward a method of refining and casting beryllium metal compositions whereby a molten liquid flux containing fluorides of beryllium, calcium, barium, and lithium are admixed with the molten beryllium composition in order to produce sound castings which are substantially free of occluded gases.

Other objects of the present invention will be apparent from the following description.

In accordance with the present invention it has been found in refining and casting beryllium metal compositions that by adding a molten liquid flux composition substantially free of moisture, wherein the flux composition contains halide compounds of beryllium, barium, calcium, and lithium, to the melt, sound beryllium castings substantially free of impurities and occluded gases may be produced. In addition, it was found that the chemical composition and the physical structure of these beryllium castings were substantially improved by the incorporation of lithium fluoride with the fluorides of beryllium, calcium and barium.

In general, when refining and casting light metals, a group wherein beryllium metal is defined, it is not generally considered desirable from a metallurgical standpoint to have strong agitation in the light metal melt as this action tends to admix the oxides and impurities with the metal rather than to permit the metal and the impurity to separate. Therefore it is important that the "motor" agitation produced in a melt be reduced to a minimum. Various refining flux compositions for melting and casting pure beryllium metal were used at temperatures in excess of 2600° F., and it was found that these fluxes fumed excessively and produced violent chemical reactions with the beryllium metal. These flux compositions generally contained admixtures of mixed halides of the alkaline earth metals and the alkali metal groups, such as the fluorides and chlorides of beryllium, calcium, barium, magnesium, sodium potassium, and lithium metals. When a flux composition contains various mixtures of these halide compounds, such as the fluorides of beryllium, calcium, and barium metals, a violent reaction occurs in the beryllium melt which necessitates adding the flux very slowly in order to keep the molten beryllium within the confines of the crucible. This violent reaction and agitation within the melt tends to admix the oxides and impurities of the melt with the beryllium metal; and upon casting the beryllium melt, the resultant castings were found to be unsound and contained impurities and occluded gases. However, when a lithium halide, preferably lithium fluoride, is added in combination with an admixture of beryllium fluoride, barium fluoride and calcium fluoride, the characteristic violent reaction with the molten beryllium metal is substantially reduced; and it was found that the flux composition could be added very rapidly to the beryllium melt with very little reaction. In addition, it was found that the flux composition of the present invention containing lithium fluoride is also a better refining flux because the resulting castings are very pure, sound and practically free of occluded gases.

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By the addition of a lithium halide, preferably lithium fluoride, to a fluxing admixture containing fluorides of beryllium, calcium, and barium metals there is provided a new and novel method for melting and casting beryllium metal. This new and novel melting practice for producing beryllium castings consists of melting beryllium in a crucible, preferably a silicon carbide crucible, in the presence of an inert atmosphere, preferably argon, and then introducing into the melt a refining flux in molten liquid form containing fluorides of beryllium, calcium, barium, and as the improvement about 7 to 20 per cent by weight of lithium fluoride. The beryllium metal used in the melting procedure may contain virgin metal, scrap and remelted beryllium metal. Virgin beryllium metal when used as received generally assays about 95 per cent beryllium, the balance being slag and mixed oxides. Remelted beryllium and the scrap introduced in corresponding melts suitably contain about 86 per cent beryllium. It was found that by utilizing the refining and casting procedure of the present invention in conjunction with the novel flux composition containing lithium fluoride, beryllium castings having a purity approaching 99 per cent may be obtained. In addition, these castings are sound and practically free of occluded gases.

The proportion of the constituents of the flux composition may be varied over a relatively wide range. The proportional percentage composition of the compounds comprising the total flux composition may be identified in the following table:

Table

	Per cent by weight
Beryllium fluoride	45–65
Calcium fluoride	7–20
Barium fluoride	7–20
Lithium fluoride	7–20

A preferred flux composition of the present invention may contain approximately 4 parts by weight (57%) of beryllium fluoride, 1 part by weight (14%) of calcium fluoride, 1 part by weight (14%) of barium fluoride and about 1 part by weight (14%) of lithium fluoride.

A typical remelting and refining cycle may be illustrated in the following manner: A beryllium metal composition is introduced into a silicon carbide crucible; and the loaded crucible is then inserted into an induction furnace utilizing a purified argon atmosphere. The melt is then raised to a temperature of approximately 2300° to 2700° F. for a period of time in order to allow the melt to come to a completely molten condition. The flux composition containing 4 parts by weight of beryllium fluoride, 1 part by weight of calcium fluoride, 1 part by weight of barium fluoride, and 1 part by weight of lithium fluoride is melted in a separate graphite crucible in order to eliminate moisture content present in the flux admixture. The molten flux is then added to the beryllium melt and no violent reaction is observed. The beryllium melt containing the flux composition is then cast into graphite transverse bar molds at a temperature of about 2600° to 2700° F. The resulting castings are sound and possess a well defined grain structure. The physical properties of the metal are excellent and the metal recovery approaches 87 per cent. Spectrographic analysis of the beryllium metal melted by this method showed highly pure beryllium metal with not a trace of lithium. Since

beryllium metal may be used as a moderator in the construction of neutronic reactors, the presence of lithium would be highly objectionable due to its high neutron capture cross section.

It will be apparent to those skilled in the art to which this invention pertains that various modifications may be made without departing from the principles of the invention as disclosed herein, and thus it is not intended that the invention should be limited other than by the scope of the appended claims.

What is claimed is:

1. A method of producing beryllium castings which comprises melting beryllium in the presence of an inert atmosphere, admixing with the beryllium melt a molten refining flux composition containing 45–65% of beryllium fluoride, about 7–20% of barium fluoride, about 7–20% of calcium fluoride, and about 7–20% of lithium fluoride at a temperature of about 2300° F., and then casting the molten beryllium metal at a temperature in excess of the melting point of beryllium metal.

2. A method of producing beryllium castings which comprises melting beryllium in the presence of an argon atmosphere, admixing with the beryllium melt a molten refining flux composition containing 57% of beryllium fluoride, about 14% of barium fluoride, about 14% of calcium fluoride, and about 14% of lithium fluoride of the combined flux composition at a temperature of about 2300° F., and then casting the resultant beryllium melt at a temperature of about 2700° F.

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