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PROCESS FOR THE ELIMINATION OF ALUMINUM AND METALS OF THE IRON GROUP FROM ZINC, ZINC ALLOYS, ETC.

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To all whom it may concern:

Be it known that I, KARL BORNEMANN, a citizen of Germany, residing at Breslau, in Prussia, Germany, have invented a certain new and useful Process for the Elimination of Aluminum and Metals of the Iron Group from Zinc, Zinc Alloys, Etc., of which the following is a specification.

The present invention relates to the purification of zinc by the removal therefrom of aluminum and the metals of the iron group. The process is applicable to all forms of commercial zinc, zinc alloys, galvanizing baths, zinc dross and residues containing metallic zinc, from which it is desired to remove the content of aluminum or metals of the iron group or both.

It is well known that various iron-aluminum alloys have relatively high melting points, and, upon cooling from a molten condition, assume a crystalline structure. The different iron aluminum alloys are also capable of forming mixed crystals with each other. The most important of the iron aluminum alloys is the one corresponding to the formula $FeAl_3$. These mixed crystals will hereinafter be briefly referred to as "compounds." What has above been said in regard to the alloys of iron with aluminum applies also to the alloys of the other metals of the iron group with aluminum, and in the present specification, for the sake of simplicity I will refer to iron aluminum alloys, as being substantially the same as alloys of the iron group metals with aluminum. I have found that it is possible to form the alloys of iron and aluminum even in the presence of a large quantity of metallic zinc, and I have further found that upon cooling the liquid mixture containing iron aluminum alloy and zinc to just above the melting point of zinc, the iron aluminum alloy will readily crystallize, and the crystals being much lighter than the molten zinc will rise in the bath and float upon the surface thereof, and can be readily removed therefrom by a simple operation, such as skimming, or the molten zinc can be drawn away from below the surface, leaving the iron aluminum alloy in the receptacle. It is thus seen that the alloy of iron and aluminum will form in the solid state in a bath of molten zinc when the latter is slightly above its melting point, this alloy being insoluble in the molten zinc at the temperature indicated. Since zinc melts at a relatively low temperature, about 419° C., the separation of the alloy from the zinc or from the major portion of the zinc can readily be effected. At temperatures slightly above the melting point of zinc, the iron aluminum alloys are practically insoluble in molten zinc, although at higher temperatures, they dissolve with some difficulty in metallic zinc. This principle for the separation of either iron or aluminum or both from the metal zinc, is accordingly applicable so long as a sufficient amount of zinc is present to form a molten bath in which the solid alloy of aluminum and iron can float.

It is also surprising that other metals, which are often present in alloys with a high zinc content, such as copper and tin, also lead which is practically always present, behave substantially the same as the zinc and hence will not in any way interfere with the operation of the process.

The process is practically carried out, starting with zinc or an alloy of zinc containing aluminum or metals of the iron group. Alloys containing zinc and aluminum can be melted, and can be added to molten alloys containing zinc and iron. The charge is then well mixed, and if at a temperature below 600 to 800° C., is preferably heated to that temperature or at least up to 500° C., in order to allow the combination between the iron and aluminum to readily take place. The bath is then cooled down nearly to the melting point of zinc, and is then allowed to stand quietly for a short time, say an hour or so, during which time the iron and aluminum alloy solidifies into crystals which have risen to the surface of the bath. The crystals may then be separated from the bath, for example, by means of skimming. As an alternative way of proceeding, the aluminum zinc alloy can be added to molten zinc iron alloy, or if desired a charge containing all three of the

metals, aluminum, iron and zinc can be melted, and then treated in the manner above described.

It is immaterial what mode of heating is employed, a reverberatory, a crucible or a kettle can be used, this preferably being lined on the inside with a refractory material.

When it is desired to remove the iron or aluminum or both, to a very complete degree, the process can be repeated one or more times. If it is desired to remove the aluminum very completely a slight excess of iron can be used, and this excess will then settle out in the bottom of the bath in the form of zinc iron alloy, as crystals, which crystals can subsequently be utilized in the treatment of further quantities of alloys containing zinc and aluminum. In this mode of working, an excess of iron is added to the alloy, the bath heated up to the temperatures above stated, and this allowed to cool to slightly above the melting point of zinc, and allowed to stand quietly until the iron aluminum alloy has risen to the top and the iron zinc alloy has settled to the bottom, after which the three layers, namely, the iron aluminum alloy, the metallic zinc and the zinc iron alloy can readily be separated from each other.

An important application of the process is its application in the treatment of galvanizing baths, which contain an alloy of zinc and iron. These baths may be treated with aluminum, from time to time, and the alloy of iron and aluminum separated, for example, by skimming. In this process it is advisable to heat the bath before or after the addition of the aluminum up to about 500° C., then allow the bath to cool to just above the melting point of zinc, after which the crystals which have risen to the surface are removed.

The working up of the residue of the process does not entail any serious difficulties. Obviously in removing the iron aluminum crystals there will ordinarily be removed some metal zinc therewith. It has been shown that from this material, the zinc content can be distilled off in a simple manner, for instance by immersing the alloy into a bath of liquid iron, and the remaining iron aluminum compound can then be employed for the production of ferro-aluminum as a saleable product. Instead of a bath of molten iron, obviously a bath of other metal of the iron group could be similarly employed.

In carrying out the process, it is usually advisable to hold the bath at about 450 to 500° C., for some time, say about three hours, in order to allow the crystals of iron-aluminum alloy to rise to the top, and to then separate at about 500° C. This may be accomplished by allowing the crucible containing the mass to spontaneously cool, from 600° C. to a temperature slightly above the melting point of zinc, during about six hours, and then skimming or tapping.

What I claim is:

1. The method of recovering metallic zinc from admixture with a metal of the iron group and aluminum, which comprises subjecting the mixture to a temperature of at least 500° C., then cooling to slightly above the melting point of zinc and thereafter separating the bulk of the solid alloy of aluminum with the metal of the iron group and the bulk of the molten zinc from each other.

2. The method of recovering metallic zinc from admixture with at least one constituent of an iron-aluminum alloy, which comprises adding the constituent of such latter alloy in which the mass is deficient, maintaining the mass at a temperature not below 500° C. until the iron and aluminum have combined to form a high melting point alloy, cooling to a little above the melting point of the zinc bath and allowing the mass to settle, and thereafter separating the major part at least of solidified iron-aluminum alloy and the major part at least of the zinc from each other.

3. In the method of claim 2, the step of adding the component of the iron-aluminum alloy in which the original material is deficient in the form of an alloy with zinc.

4. The method of removing aluminum and iron-group metal from materials containing metallic zinc which comprises adding to the molten zinc containing an excess of one of the constitutents of iron-group-aluminum alloy a material containing the other constituents of such alloy, maintaining the molten mass at a temperature sufficient to effect combination of the iron group metal and aluminum, and thereafter separating the alloy of aluminum and iron-group metal, and the zinc from each other.

5. The method of removing aluminum and iron-group metal from materials containing metallic zinc which comprises adding to the molten zinc containing an excess of one of the constituents of iron-group-aluminum alloy a material containing the other constituent of such alloy, heating the mixture to a temperature at which iron-group metal and aluminum will readily combine, cooling nearly to the solidifying point of zinc, whereby the aluminum-iron-group alloy will solidify, and thereafter separating the alloy of aluminum and iron-group metal and the zinc from each other.

6. The method of removing aluminum and iron-group metal from materials containing metallic zinc which comprises adding to the molten zinc containing an excess of one of the constituents of iron-group-aluminum alloy a material containing the other constituent of such alloy, stirring the mass while at a temperature of at least 500° C., to effect the combination of the iron-group metal

with the aluminum, cooling the mixture sufficiently to cause solidification of the alloy of iron-group metal and aluminum but not sufficiently to solidify the zinc, allowing said alloy to rise to the surface of the zinc bath and thereafter separating the alloy of aluminum and iron-group metal, and the zinc from each other.

7. In the method of claim 1, the step of recovering zinc adhering to the separated alloy of iron-group metal and aluminum, which comprises adding such material to a bath of metal of the iron-group while such bath is at a temperature above the boiling point of zinc, thereby vaporizing the zinc, and collecting the volatilized zinc.

8. The method of recovering metallic zinc from admixture with aluminum and a metal of the iron-group which comprises heating the mixture to a temperature at which the aluminum and metal of the iron-group form an alloy, cooling the molten mass to a temperature slightly above the melting point of zinc until the alloy crystallizes, and separating the molten zinc from the alloy crystals.

9. The method of recovering metallic zinc from admixture with aluminum and a metal of the iron-group which comprises heating the mixture to a temperature at which the aluminum and metal of the iron-group form an alloy, stirring the molten mass, cooling to a temperature slightly above the melting point of zinc until the alloy crystallizes, and separating the molten zinc from the alloy crystals.

10. The method of recovering metallic zinc from admixture with iron and aluminum which comprises heating the mixture to a temperature at which the iron and aluminum form an alloy, cooling the mass to a temperature slightly above the melting point of zinc to cause the ferro-aluminum alloy to crystallize, and separating the molten zinc from the crystals.

11. The method of recovering metallic zinc from admixture with iron and aluminum which comprises heating the mixture to at least 500° C., cooling the mass to a temperature slightly above the melting point of zinc, and separating the molten zinc from the resultant ferro-aluminum crystals.

12. The method of recovering metallic zinc from admixture with iron and aluminum which comprises heating the mixture to at least 500° C., cooling the mass to a temperature slightly above the melting point of zinc, allowing the molten mass to stand until the resultant crystals rise to the top, and separating the floating crystals from the molten zinc.

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Witnesses:
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