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PROCESS OF DEBISMUTHIZING LEAD

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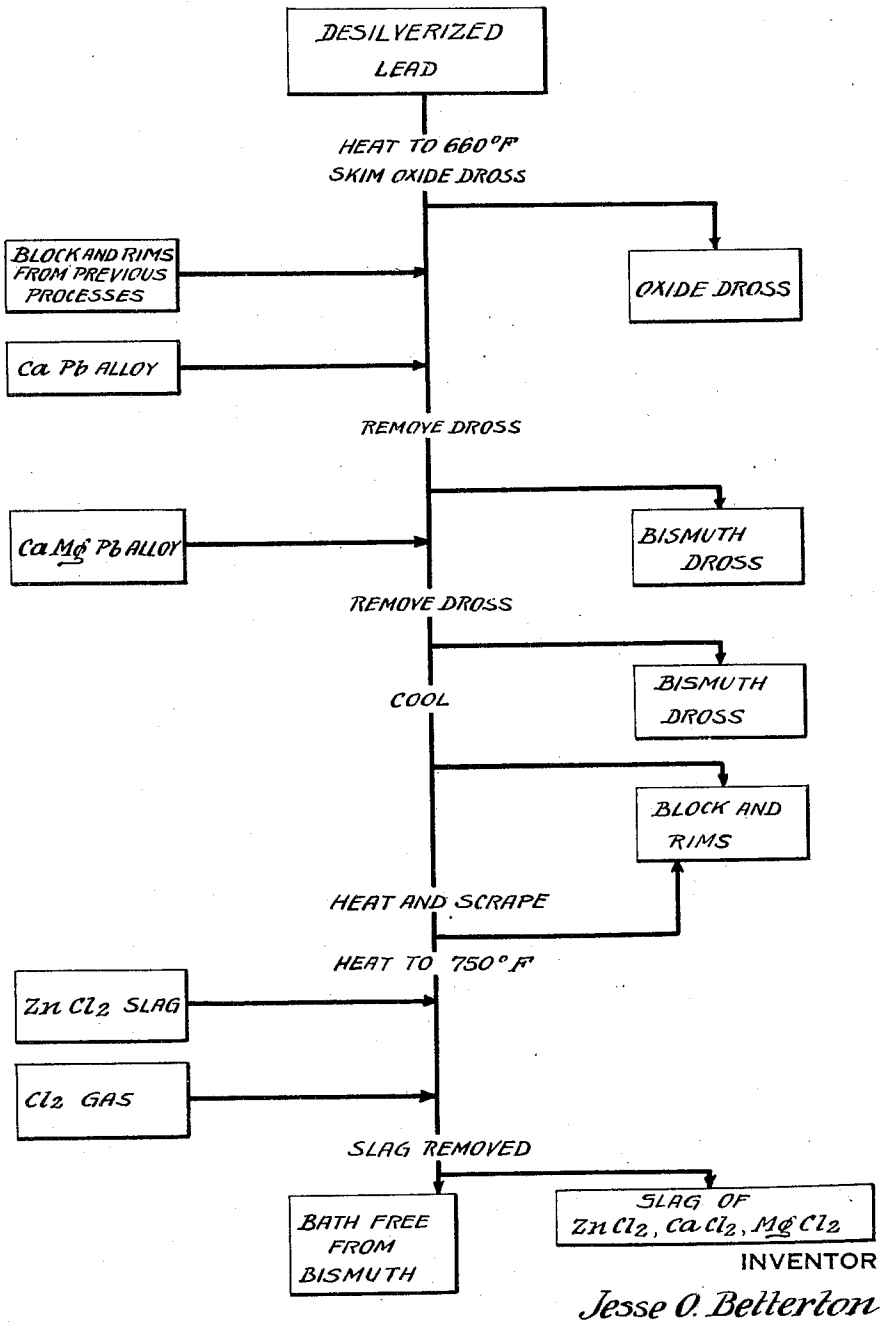

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PROCESS OF DEBISMUTHIZING LEAD

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This invention relates to the refining of metals and more particularly to the removal of bismuth from lead.

The invention is especially applicable to the removal of bismuth from desilverized lead and provides for the substantial elimination of the bismuth therefrom. The process is adapted for treating corroding lead, and is capable of reducing the bismuth content thereof to less than .005%.

The invention also provides for the elimination of the debismuthizing reagents whereby the metal of the bath may be made to conform to refined lead specifications and will be in a marketable condition.

The invention further consists in the new and novel features of operation and the new and original arrangements and combinations of steps in the process hereinafter described and more particularly set forth in the claims.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description in which a particular commercial embodiment thereof is disclosed. It will be understood however, that the processes and the steps thereof may be modified in various respects without departing from the broad spirit and scope of the invention.

The drawing is a flow sheet illustrating one form of the present process.

In the following description and in the claims the various steps in the process and the details comprising the invention will be identified by specific names for convenience but they are intended to be as generic in their application as the art will permit.

In accordance with the present invention calcium and magnesium are used as reagents for the removal of bismuth. These reagents may be used in the form of calcium-lead alloys and magnesium-lead alloys or may be combined as a calcium-magnesium-lead alloy. The alloys may be added to the bath during the same operation or they may be successively added and the dross produced may be separately removed. In any case, the bulk of the bismuth enters the dross and is removed from the lead. The bismuth content of the lead is then still further reduced by selective freezing, during which the bismuth tends to enter the solidified portions, thereby substantially eliminating the bismuth content from the bath.

Referring to the process more in detail the bath of lead, as for example, previously desilverized lead, is heated to a temperature sufficiently to make it molten, that is, between 625° F. and 700° F. and a predetermined quantity of calcium-lead alloy is added thereto. A high bismuth dross is then formed which may be removed from the bath and treated for the recovery of bismuth therefrom. A quantity of magnesium-lead alloy or calcium-magnesium-lead alloy is then added to the bath and a further quantity of dross is formed which may also be removed and treated for the recovery of the metal values. The lead bath may then be cooled sufficiently to solidify a portion thereof, which contains a substantial amount of the remainder of the bismuth.

Thereafter, the bath may be treated by chlorine to form calcium and magnesium chlorides which separate in the form of a dross and may be removed from the bath, leaving the metal substantially free from these alloys.

As a specific example of a manner in which the present process may be carried out, a quantity of lead from which the bismuth is to be removed may be applied to a kettle and heated to a temperature of approximately 660° F. An oxide dross is formed on the surface of the bath and may be removed in any well known manner. Blocks and rims from previous processes may then be added to the bath, if desired, and allowed to melt therein.

An alloy of calcium and lead is then added to the molten bath and stirred a sufficient length of time to become thoroughly incorporated therein. A calcium-bismuth-lead dross is formed which contains a large percentage of the bismuth content of the bath and is removed therefrom in any convenient manner.

The bath is then maintained at a temperature of substantially 660° F. and a comparatively small quantity of a magnesium-lead alloy is added thereto and thoroughly incorporated therewith, as by stirring. A magnesium-calcium-bismuth-lead dross is formed which contains further quantities of bismuth and materially reduces the bismuth content of the bath. This dross may be removed and treated in any desired manner for the recovery of the metal values.

The kettle is then slowly cooled and blocks and rims are formed from the portion of metal which first solidifies. These blocks and rims contain a substantial portion of the remaining bismuth and leave the bath substantially free from this element. They may be removed and added to subsequent baths of lead for further treatment in the manner pointed out above.

After the blocks and rims have been removed, the kettle is again heated and scraped to remove the metal which is solidified. The scrapings may be added to the blocks, if desired. The lead now contains a considerable quantity of calcium and magnesium which must be removed to render the lead suitable for market as refined lead. This is accomplished by heating the bath to a temperature of 750° F. and adding a slag of zinc chloride in sufficient quantity to completely cover the surface thereof and to form a seal. Chlorine gas is then introduced into the lead in sufficient quantity to unite with the calcium and magnesium and form calcium and magnesium chlorides and if desired, to produce an excess of lead chloride which may be utilized in treating the bismuth drosses above mentioned. The slag of zinc chloride, calcium chloride and magnesium chloride may then be removed from the bath and the refined lead pumped to a suitable container for subsequent use.

The zinc chloride slag causes the chlorides of calcium, magnesium and lead to form a fluid slag in which secondary reactions may occur to accomplish selective chloridization of the calcium and magnesium. Furthermore the formation of litharge is prevented or if any should be formed it remains in solution in the fluid slag. Without the zinc chloride a dry dross would be produced which would be difficult to handle and would not promote the formation of magnesium and calcium chlorides.

In a particular instance 200 pounds of corroding lead containing .045% of bismuth were treated in the above manner with calcium and magnesium alloys, containing substantially .1% of calcium and .1% magnesium with respect to the total quantity of lead in the bath. After skimming the calcium-bismuth-lead-dross, the bismuth in the bath was found to have been reduced to approximately .03%. After skimming the magnesium-bismuth-calcium-lead dross, the bismuth content of the bath was reduced to .009%. After freezing and removing the blocks and rims, the bismuth content of the bath was approximately .004%.

Although the temperature of the bath may be varied within limits, it has been found that temperatures of approximately 660° F. are preferable for the addition of the calcium and magnesium alloys and for the skimming operations. For the chlorine treatment a temperature of approximately 750° F. may be employed.

It is to be noted that in the above process, although the calcium and magnesium alloys have been added separately, they may be combined if desired and added in a single step, in which case a calcium-magnesium-bismuth-lead dross will be obtained. It is obvious also that the calcium and magnesium may be added to the bath in various forms. The lead alloys described above have been found particularly suitable for this purpose. Also the invention may be applied to the removal of bismuth from various metals and is not to be limited to the removal of this element from lead. The entire process may be carried out as an independent method of treating metals, or it may be combined with other refining processes, as will be apparent to a person skilled in the art.

Although the use of a magnesium-lead alloy was described in detail, it is to be noted that a calcium-magnesium-lead alloy may be used in the second stage of the bismuth removal if desired. In this case the amount of calcium which is added during the first stage of the treatment may be correspondingly reduced so that the total amount of calcium is not increased by the use of the calcium-magnesium-lead alloy. Furthermore, the process can be combined as a single step in which a suitable quantity of a calcium-magnesium-lead alloy is added to the bath to remove the desired amount of bismuth.

Although certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the several steps of the process and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding calcium and magnesium to said bath, removing the bismuth as a dross combined with said calcium and magnesium and removing said calcium and magnesium by the addition of chlorine whereby a chloride dross is produced.

2. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding a calcium alloy to said

bath to form a high bismuth dross, removing said dross, adding a magnesium alloy to said bath to form a second high bismuth dross, and removing said second dross.

3. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding a calcium-lead alloy to said bath to form a high bismuth dross, removing said dross, adding a magnesium-lead alloy to said bath to form a second high bismuth dross, and removing said second dross.

4. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding calcium to said bath to form a high bismuth dross, removing said dross, adding magnesium to said bath to form a second high bismuth dross, and removing said second dross.

5. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding a calcium-lead alloy and a magnesium-lead alloy to said bath to form a high bismuth dross, removing said dross, and adding chlorine to said bath to form calcium and magnesium chlorides and removing said chlorides as a dross.

6. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath, adding a calcium-lead alloy to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

7. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath, adding a calcium-lead alloy to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, adding a zinc chloride slag to said bath to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

8. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

9. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, heating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

10. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, cooling said bath to form blocks and rims, removing said blocks and rims, reheating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

11. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and a magnesium lead alloy to produce a high bismuth dross, removing said high bismuth dross, cooling said bath to form blocks and rims, removing said blocks and rims, reheating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

12. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while

maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, heating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

13. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

14. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., removing any oxide dross that may be formed, adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding calcium to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding magnesium to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

15. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., removing any oxide dross that may be formed, adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

16. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath, adding calcium to said bath in the form of a calcium-lead alloy whereby a calcium-bismuth-lead dross is produced, removing said dross, adding a calcium-magnesium-lead alloy to said bath to produce a calcium-magnesium-lead-bismuth dross, removing said dross and treating the bath to remove the remaining calcium and magnesium therefrom.

17. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath, adding a calcium-magnesium-lead alloy to said bath whereby a high bismuth dross is formed, removing said dross and treating the bath with chlorine for the removal of the calcium and magnesium therefrom.

18. The process of refining lead containing bismuth as an impurity which comprises melting said lead and forming a molten bath thereof, incorporating in said bath a calcium-yielding substance and magnesium-yielding substance to effect the removal of bismuth as a dross and introducing a chloridizing reagent in said molten bath to effect a simul-

bath to form a high bismuth dross, removing said dross, adding a magnesium alloy to said bath to form a second high bismuth dross, and removing said second dross.

3. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding a calcium-lead alloy to said bath to form a high bismuth dross, removing said dross, adding a magnesium-lead alloy to said bath to form a second high bismuth dross, and removing said second dross.

4. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding calcium to said bath to form a high bismuth dross, removing said dross, adding magnesium to said bath to form a second high bismuth dross, and removing said second dross.

5. The process of removing bismuth from lead which comprises heating said lead to form a bath, adding a calcium-lead alloy and a magnesium-lead alloy to said bath to form a high bismuth dross, removing said dross, and adding chlorine to said bath to form calcium and magnesium chlorides and removing said chlorides as a dross.

6. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath, adding a calcium-lead alloy to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

7. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath, adding a calcium-lead alloy to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, adding a zinc chloride slag to said bath to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

8. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

9. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, heating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

10. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and stirring to produce a high bismuth dross, removing said high bismuth dross, adding a magnesium-lead alloy to produce a second high bismuth dross, removing said second dross, cooling said bath to form blocks and rims, removing said blocks and rims, reheating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

11. The process of treating lead for the removal of bismuth therefrom, which comprises melting said lead to form a bath at a temperature of substantially 660° F., adding a calcium-lead alloy and a magnesium lead alloy to produce a high bismuth dross, removing said high bismuth dross, cooling said bath to form blocks and rims, removing said blocks and rims, reheating said metal to approximately 750° F., adding a zinc chloride slag thereto to form a seal, treating said bath with chlorine to form calcium chloride and magnesium chloride and an excess of lead chloride, and removing the dross comprising chlorides of zinc, lead, calcium and magnesium, whereby the lead is substantially freed from the above metals.

12. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while

maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, heating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

13. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

14. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., removing any oxide dross that may be formed, adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding calcium to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding magnesium to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

15. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath at a temperature of approximately 660° F., removing any oxide dross that may be formed, adding to said bath blocks and rims from previous processes and allowing the same to melt therein, adding a calcium-lead alloy to said bath to form a calcium-lead-bismuth dross, stirring to effect an intimate contact of said alloy while maintaining the temperature at approximately 660° F., removing said dross, adding a magnesium-lead alloy to said bath while maintaining approximately the same temperature and stirring to effect an intimate mixture and produce a lead-magnesium-calcium-bismuth dross, removing said last mentioned dross, cooling said bath to form blocks and rims, removing said blocks and rims and adding the same to a subsequent bath in the step above mentioned, reheating the bath to a temperature of approximately 750° F., covering the same with a zinc chloride slag, applying chlorine gas to said bath to produce chlorides of calcium, magnesium and lead, and to form a dross of said chlorides and removing the chloride dross from said bath, whereby the metal thereof is substantially freed from the above named elements.

16. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath, adding calcium to said bath in the form of a calcium-lead alloy whereby a calcium-bismuth-lead dross is produced, removing said dross, adding a calcium-magnesium-lead alloy to said bath to produce a calcium-magnesium-lead-bismuth dross, removing said dross and treating the bath to remove the remaining calcium and magnesium therefrom.

17. The process of refining lead for the removal of bismuth therefrom which comprises melting said lead to form a bath, adding a calcium-magnesium-lead alloy to said bath whereby a high bismuth dross is formed, removing said dross and treating the bath with chlorine for the removal of the calcium and magnesium therefrom.

18. The process of refining lead containing bismuth as an impurity which comprises melting said lead and forming a molten bath thereof, incorporating in said bath a calcium-yielding substance and magnesium-yielding substance to effect the removal of bismuth as a dross and introducing a chloridizing reagent in said molten bath to effect a simul-

taneous removal of calcium and magnesium as a dross.

19. The process of refining lead containing bismuth as an impurity which comprises melting said lead and forming a molten bath thereof, incorporating in said bath calcium and magnesium to effect the removal of bismuth as a dross, removing said bismuth-containing dross and introducing a chloridizing reagent in said molten bath to effect a simultaneous removal of calcium and magnesium as a dross.

In testimony whereof I have hereunto set my hand.

JESSE OATMAN BETTERTON.