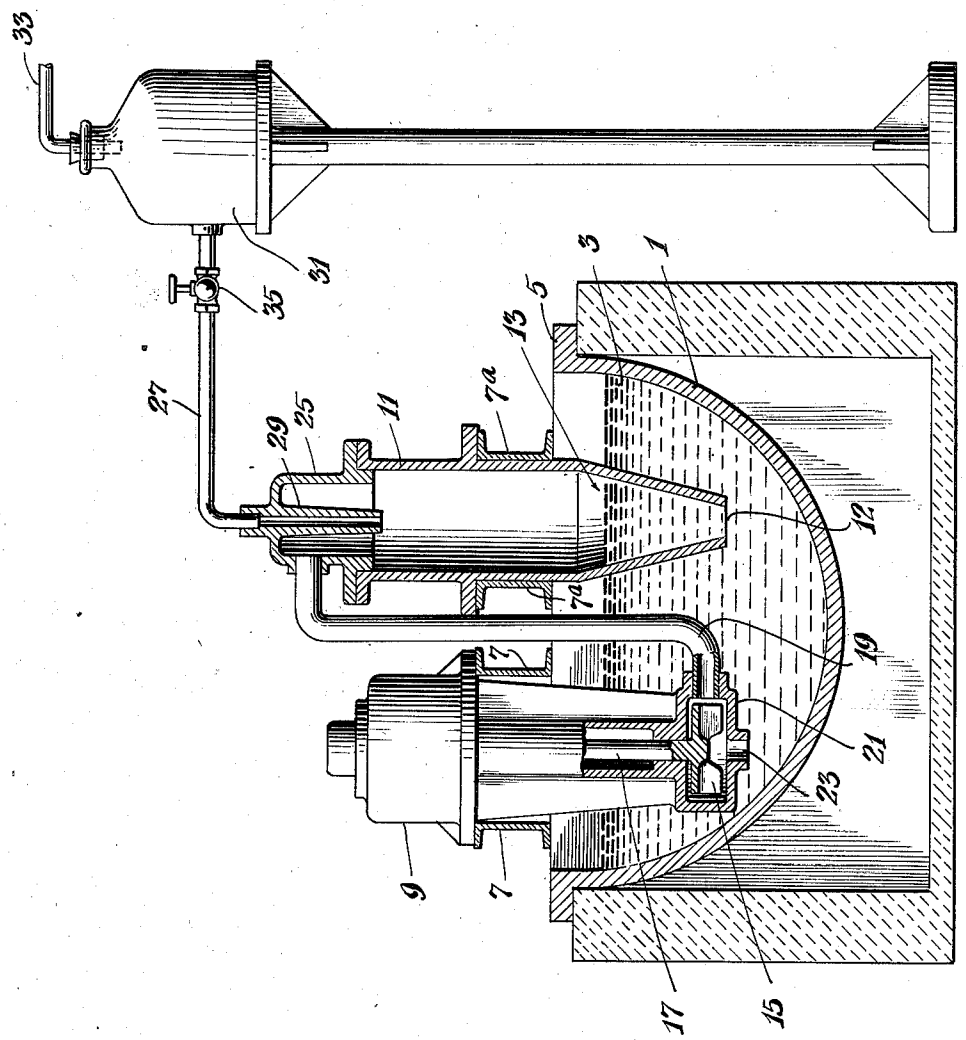
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RECOVERING TIN

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RECOVERING TIN

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It is a known fact that none of the commercial alloys of lead and tin, which alloys are classed as solder metals, are actually pure lead-tin alloys, but that they contain varying percentages of other contaminating metals in relatively small, but none the less appreciable, amounts which, when they fall within prescribed limits, are tolerated by the market specifications because of the difficulty and cost of a complete purification of these alloys.

As a large proportion of solder on the market is obtained as a result of metallurgical operations on secondary metals, the production and refining of such solder to within the limits of market tolerance is a prolonged and complex operation, involving many correlated operations.

One of the objects of the present invention is to provide a process which will produce pure solder on a commercial scale and with comparatively low operating cost.

Another object of the invention is to provide an improved process for the production of pure tin.

Further objects and advantages of the process will become apparent as the invention proceeds, and the features of novelty will be pointed out in greater particularity in the appended claims.

In general, the present invention relates to the precipitation of pure tin from anhydrous stannic chloride and the direct production of pure solder therefrom. The procedure comprises in one of its aspects the circulation of a molten bath of pure lead in reactive contact with stannic chloride and in the presence of a displacing agent for the tin, such as for example, molten zinc. In another aspect, the invention involves the precipitation of tin from stannic chloride by molten zinc, using pure tin as a carrier for the zinc.

The invention will be understood more readily from a consideration of the accompanying drawing which represents in sectional elevation a type of system suitable for carrying out the process of the present invention.

In the drawing, a kettle 1, made of cast iron and of suitable capacity and heated by any suitable means (not shown) contains a bath of molten metal 3, for example, lead, where solder is to be made.

Supported on the rim 5 of the kettle 1 are pairs of channels 7, 7, 7a, 7a, which support a motor 9 and a vessel, or cylinder 11, providing a reaction chamber 13. It is understood, of course, that the open end 12 of the vessel 11 is constantly immersed in the molten bath 3. The motor 9 operates a centrifugal pump 15, immersed in the bath of metal 3, through a drive shaft 17. A conduit 19 connects the interior of the pump housing 21 with the hood 25 of the reaction vessel 11 so that molten metal entering the pump housing 21 through the intake 23 will be delivered by the pump 15 through the conduit 19 into the hood 25, the metal entering the hood tangentially, so that the swirling action produced thereby will assure maximum reactive contact between the metal and the stannic chloride which enters the reaction vessel 11 through a pipe 27 connecting a tubular passage 29 in the hood 25 with a reservoir 31 containing liquid stannic chloride received through a pipe 33 leading to a supply thereof, not shown. A valve 35 controls the flow of stannic chloride from the reservoir 31 into the reaction cylinder 11; and, of course, suitable control valves may be placed in the pipe 33 as may be required.

Assuming that the bath 3 is molten lead, carrying zinc as the tin displacing metal, as the bath contacts with the stannic chloride in the reaction cylinder 11, the zinc displaces the tin from the stannic chloride, precipitating metallic tin therefrom, which tin combines with the lead to form solder, a layer of zinc chloride forming on the surface of the bath. It is found in practice that the efficiency of the operation is at its maximum when the zinc is added to the bath gradually, in substantial proportions to its chlorine equivalent, so as to substantially just renew the zinc content of the bath as the precipitation of the tin proceeds, the precipitation of the tin taking place in accordance with the reaction

$$SnCl_4 + 2\,Zn \rightarrow 2\,ZnCl_2 + Sn.$$

When the approximately desired tin content has been obtained, as determined by analysis of the bath, circulation of the bath is continued without further addition of zinc, until complete elimination of any residual zinc has been reached. By using pure metals, e. g. pure refined lead and pure zinc, such as electrolytic zinc, pure solder will be obtained, together with pure zinc chloride. This zinc chloride is skimmed off for sale and the solder is cast into bars for market.

The following specific example illustrates the process:

There were melted in the kettle 1, 4965 parts by weight of refined lead. To this lead bath were added 198.6 parts by weight of pure zinc to make a zinc content of approximately 4% in the bath. The reaction mechanism was inserted in the bath and connected to a supply of stannic chloride

which is conveniently contained in drums containing 1000 lbs. of the stannic chloride. The zinc was added to the bath as the displacing reagent for the tin of the tetrachloride.

The circulating pump 15 was started and the metal was pumped through the reaction vessel 11 as stannic chloride was supplied thereto, which was contacted with the metal at an average addition rate of approximately 500 lbs. of stannic chloride per hour, the actual rate of addition being from 300 to 700 lbs. of stannic chloride per hour.

Zinc was added sufficiently rapidly to maintain approximately the 4% zinc concentration in the bath. The temperature of the bath was maintained at from approximately 850° to approximately 900° F. during the run.

In the entire run there were utilized a total of 4440 parts by weight of stannic chloride analyzing 44.7% Sn and 3270 parts by weight of zinc.

The products recovered were 6758 parts by weight of solder, analyzing 70.9% Pb, 29.1% Sn, and 5073 parts by weight of zinc chloride slag, analyzing 98% $ZnCl_2$, 0.2% Sn, 0.1% Pb and 1.45% water insoluble.

The final solder produced was free from zinc, containing only the lead and tin.

Should it be desired to make pure tin instead of solder metal, the procedure would be the same except that a commercially pure tin would be used instead of the lead. The purity of the metal produced is in any case dependent upon the purity of the metals present in the bath. Thus, if refined lead were used, and electrolytic zinc were employed, entirely pure lead-tin solder would be obtained; or if, instead of refined lead, a commercially pure grade of tin were used, such as electrolytic tin or Straits tin, with electrolytic zinc, the product would be pure tin.

In the latter instance, it may be pointed out that the use of tin in conjunction with the zinc is desirable because of lower operating temperatures which may be employed; however, there is no action on this tin, which serves only as a carrier for the zinc and as a collecting medium for the precipitated tin. It is not itself affected by the action taking place.

What is claimed is:

1. The process of recovering tin from anhydrous stannic chloride which comprises circulating a molten bath comprising a tin-displacing metal and a carrier therefor, passing anhydrous liquid stannic chloride into reactive contact with the circulating molten bath, allowing the bath and stannic chloride to interact to displace the tin from the stannic chloride by the action of the tin-displacing metal in the bath, and collecting the displaced tin in the said carrier, while maintaining a supply of the tin-displacing metal continuously present in the bath during displacement of the tin, thereby forming a directly marketable slag containing substantially only the chloride of the tin-displacing metal.

2. The process of recovering tin from anhydrous stannic chloride which comprises forming a molten metallic bath comprising a tin-displacing metal and a carrier metal therefor, continuously circulating a portion of the bath into reactive contact with an incoming supply of liquid stannic chloride thereby causing a displacement of the tin from the stannic chloride, collecting the displaced tin in the said carrier metal while maintaining a supply of the tin-displacing metal continuously present in the bath during displacement of the tin, thereby forming a directly marketable slag containing substantially only the chloride of the tin-displacing metal, and finally removing all of the tin-displacing metal by treating the bath with chlorine.

3. The process of making solder which comprises forming a molten bath of lead, adding zinc thereto while maintaining the bath molten, circulating the said bath into reactive contact with an incoming supply of stannic chloride, allowing the zinc in the bath to displace the tin of the stannic chloride with attendant formation of molten zinc chloride slag allowing the displaced tin to enter the lead, maintaining continuously a supply of zinc in the bath, and recovering the said zinc chloride free from lead chloride, and the resulting solder.

4. The process of making solder which comprises forming a molten bath of lead, adding zinc thereto while maintaining the bath in molten condition, continuously circulating a portion of the said bath into reactive engagement with an incoming supply of stannic chloride, allowing the zinc in the bath to displace the tin of the stannic chloride with attendant formation of molten zinc chloride slag, allowing the displaced tin to enter the lead, continuing the circulation of the bath and the contacting thereof with further quantities of stannic chloride until the required amount of tin has been built up in the lead and adding fresh quantities of zinc to the bath during the circulation thereof until the desired tin content of the bath has been obtained, thereby avoiding formation of any substantial amounts of lead chloride in the resulting zinc chloride slag.

5. The process of making solder which comprises forming a molten bath of lead, adding zinc thereto while maintaining the bath in molten condition, continuously circulating a portion of the said bath into reactive engagement with an incoming supply of stannic chloride, allowing the zinc in the bath to displace the tin of the stannic chloride with attendant formation of molten zinc chloride slag, allowing the displaced tin to collect in the lead, continuing circulating the bath and stannic chloride in reactive engagement until the requisite amount of displaced tin has collected in the lead, while maintaining the zinc content of the bath substantially constant by adding thereto fresh quantities of zinc in approximately the same amount and rate equivalent to the zinc consumption from the bath, thereby avoiding formation of any substantial amount of lead chloride, and separately recovering the resulting pure zinc chloride and solder.

6. The process of making pure solder which comprises forming a molten bath of pure lead, adding pure zinc thereto while maintaining the bath in molten condition, continuously circulating a portion of the said bath into reactive engagement with an incoming supply of stannic chloride, allowing the zinc in the bath to displace the tin of the stannic chloride with attendant formation of molten zinc chloride slag, allowing the displaced tin to collect in the lead, continuing circulating the bath and stannic chloride in reactive engagement until the requisite amount of displaced tin has collected in the lead, while maintaining the zinc content of the bath substantially constant by adding thereto fresh quantities of pure zinc in approximately the same amount and rate equivalent to the zinc consumption from the bath thereby avoiding formation of any substantial amounts of lead chloride, completely removing the residual zinc from the bath,

and separately recovering the resulting pure zinc chloride and pure solder.

7. The process of making pure solder which comprises forming a molten bath of pure lead, adding pure zinc thereto while maintaining the bath in molten condition, continuously circulating a portion of the said bath into reactive engagement with an incoming supply of stannic chloride, allowing the zinc in the bath to displace the tin of the stannic chloride with attendant formation of molten zinc chloride slag, allowing the displaced tin to collect in the lead, continuing circulating the bath and stannic chloride in reactive engagement until the requisite amount of displaced tin has collected in the lead, while maintaining the zinc content of the bath substantially constant by adding thereto fresh quantities of pure zinc in approximately the same amount and rate equivalent to the zinc consumption from the bath until the requisite amount of tin is collected in the bath thereby avoiding formation of any substantial amounts of lead chloride, treating the bath with chlorine to eliminate the last of the zinc, and separately recovering the resulting pure zinc chloride and the pure solder.

8. The process of separating pure tin from anhydrous stannic chloride which comprises displacing the tin therefrom with pure molten zinc in the presence of pure molten metal compatible with tin as carrier for the zinc, collecting the displaced tin in the tin carrier while continuously maintaining a quantity of zinc in the bath to avoid any substantial chloridizing of the said carrier, and completely eliminating residual zinc from the bath.

9. The process of separating pure tin from anhydrous stannic chloride which comprises forming a molten bath of substantially pure metal compatible with tin, adding zinc thereto until substantially eutectic proportions are reached, reactively contacting the resulting molten bath with anhydrous stannic chloride to displace the tin therefrom with the zinc, maintaining the zinc content of the bath substantially constant by adding additional quantities of zinc substantially in accordance with the conversion of the zinc in the bath into zinc chloride thereby avoiding chloridizing the said metal, and finally removing the residual zinc from the metal of the bath.

10. The process of making pure tin from anhydrous stannic chloride which comprises providing a molten bath of pure metallic tin, reactively contacting the same with anhydrous stannic chloride in the presence of molten pure metallic zinc thereby effecting a displacement of the tin from the stannic chloride by the zinc, collecting the displaced tin in the molten tin bath, and finally eliminating residual zinc from the bath.

11. The process of making pure tin from anhydrous stannic chloride which comprises forming a molten bath of substantially pure tin, adding zinc thereto until substantially eutectic proportions are reached, reactively contacting the resulting molten bath with anhydrous stannic chloride to displace the tin therefrom with the zinc, maintaining the zinc content of the bath substantially constant by adding additional quantities of zinc substantially in accordance with the conversion of the zinc in the bath into zinc chloride, and finally chloridizing the residual zinc from the metal of the bath with chlorine.

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