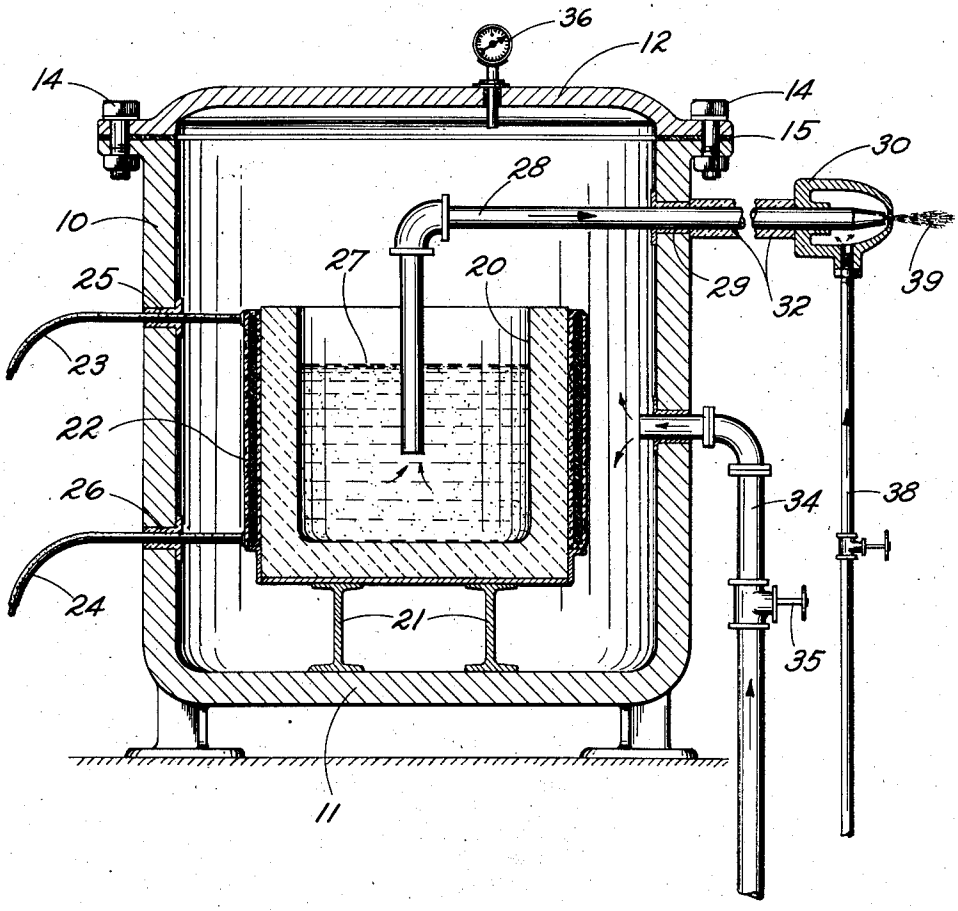
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METHOD AND APPARATUS FOR MELTING METALS

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METHOD AND APPARATUS FOR MELTING METALS

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9 Claims. (Cl. 117—105)

This invention relates to methods and apparatus for melting metals, and especially for melting metals of high purity, such as substantially pure aluminum, preparatory to atomizing the molten metal to provide uncontaminated spray deposited metallic coatings. The invention will be described herein with particular reference to high purity aluminum, but it is to be understood that the invention has application to other metals as well.

Spray deposits of high purity aluminum (preferably over 99% pure) are used extensively in electrodes of electrolytic condensers and similar devices. The aluminum deposits must be substantially free from contamination otherwise the efficiency and life of the electrodes are greatly reduced. The fact that aluminum has the property of actively dissolving many other substances when in the fluid state has made it very difficult to produce spray deposited coatings of substantially pure aluminum at low cost, for it has heretofore been impractical to produce such coatings except by means of spray guns in which a small wire of high purity aluminum is fused, and immediately atomized by a gaseous blast. Obviously a great saving in the cost of the metal used can be effected by employing pigs, bars or billets of substantially pure aluminum rather than expensive aluminum wire which is now required.

It is accordingly an object of my invention to provide a method and apparatus whereby metals such as aluminum can be fused without contamination. Another object is to provide a method and apparatus whereby the metal so fused can be conducted to a desired point and there atomized or sprayed all without contamination. Another object is to provide a method and apparatus whereby pressure can be applied to the fused aluminum without subjecting the crucible containing the metal to destructive forces.

Further objects and advantages of my invention will become apparent from the following description of a preferred form thereof, reference being made to the accompanying drawing which illustrates a vertical section through a preferred form of apparatus for carrying out my invention.

Briefly, I preferably accomplish the objects noted above, and other objects and advantages by melting the aluminum or other metal in a crucible composed of a material which will not contaminate the metal even if dissolved therein, aluminum oxide being employed in the melting of aluminum. The crucible may be heated electrically. From the crucible the metal is conducted to a desired point of discharge such as a spray nozzle, through pipes or conduits composed of the same material as the crucible, with the result that the metal never comes into contact with any material which might contaminate it, from the time that it is placed in the crucible until it is discharged. In order to provide pressure for forcing the molten metal from the crucible to the spray nozzle I preferably enclose the crucible and heating means within a strong metallic pressure chamber and apply pressure to the aluminum by forcing an inert gas into the pressure chamber. As the pressure of the gas is the same on both the inside and outside of the crucible, the crucible is not subject to any destructive forces although the metal may be discharged at considerable pressure.

In the drawing I have illustrated a preferred form of apparatus for carrying out my invention as comprising a pressure chamber 10 of generally cylindrical form having a closed bottom portion 11 and a removable top 12 which may be clamped securely on the cylindrical portion 10 by means of a number of bolts 14, the gasket 15 being employed to provide a leakproof joint.

The crucible 20, preferably composed of a refractory material which will not contaminate the metal even though dissolved therein (aluminum oxide is particularly suitable for the melting of aluminum) may be supported within the pressure vessel 10 in any convenient manner as by rails 21 resting on the bottom 11 of the chamber. Electric heating coils indicated diagrammatically at 22 surround the chamber, the lead in wires 23 and 24 for the coils passing through the wall of the chamber, and suitable bushings 25 and 26 being employed to prevent the escape of gas around the wires.

In operation, pigs composed of high purity aluminum are placed within the crucible 20 and the curent applied to melt the pigs thus producing the molten aluminum indicated within the crucible at 27. To conduct the molten aluminum to the outside of the chamber a conduit 28, preferably composed of the same refractory, i. e., aluminum oxide in this instance, is employed. The conduit passes through the wall of the pressure chamber 10, a bushing 29 being employed to prevent leakage at this point, and extends to the spray nozzle 30 which may be disposed at any convenient point. Preferably the aluminum oxide conduit 28 is covered with insulation as indicated at 32 at least in the region outside of the pressure vessel 10. This prevents the aluminum from cooling off and solidifying in the aluminum oxide conduit. If desired, the conduit may be heated in any convenient manner to maintain the metal in the fluid state.

To force the molten aluminum through the conduit 28, gas under pressure is pumped into the pressure chamber 10 through a pipe or conduit 34, the flow being controlled by a valve 35 and the pressure within the pressure chamber being indicated by a pressure gage 36. Preferably an

inert gas such as nitrogen is employed. The pressure of the gas on the surface of the molten aluminum 27 will cause the aluminum to flow outwardly from the conduit 28 to the spray 30 where a blast of air or other suitable gas applied through a conduit 38 functions to atomize the aluminum into the spray indicated at 39.

By my invention it is possible to produce a sprayed coating of high purity aluminum from aluminum pigs without the necessity of employing high purity aluminum wire as has heretofore been the case. By my method the aluminum is fused in a crucible composed of material which even if it should be dissolved in the aluminum would not contaminate the aluminum. By my method and apparatus it is possible to discharge molten metals under pressure without subjecting the crucible containing the metal to any substantial differences in pressure. In addition the cost of melting the metal is reduced for the pressure container surrounding the crucible also functions to prevent undue loss of heat from the crucible. My apparatus can be constructed at low cost and the economies of operation and of material are such that the cost of spraying substantially pure metal is greatly reduced as compared to the cost of spraying such metal by prior methods.

In the foregoing specification the invention has been described particularly with reference to spraying of high purity aluminum. It will be obvious that the invention may be adapted to other uses, for example, other metals may be employed in conjunction with crucibles composed of materials which will not contaminate such metals. The arrangement of the spray nozzle may be varied, for example, the molten metal can be permitted to flow to the spray nozzle by gravity rather than by pressure. It will also be evident that my arrangement of crucible and pressure chamber may be useful in conjunction with processes other than the spraying of metals, such as die casting or other processes wherein it is desired to discharge molten metal under pressure. Various other changes and modifications in my invention will be evident to those skilled in the art. Therefore, it is to be understood that my patent is not limited to the preferred form of my invention described herein, or in any manner other than by the appended claims when given the range of equivalents to which my patent may be entitled.

I claim:

1. In combination, in an apparatus for fusing aluminum of high purity, a crucible composed of substantially pure aluminum oxide, means for heating the crucible, a closed pressure chamber surrounding said crucible, the walls of said pressure chamber being spaced from the crucible, means increasing the pressure of the gas within said chamber, and a conduit composed of substantially pure aluminum oxide extending from said crucible to the exterior of said pressure chamber.

2. In combination, in an apparatus of the type described, a refractory crucible composed of material of low tensile strength, means for heating the crucible, and means for discharging molten metal from said crucible at a pressure which would otherwise subject the material of said crucible to destructive forces comprising a closed pressure chamber surrounding said crucible and spaced therefrom, means for supplying gas under pressure to said chamber, said gas exerting substantially equal pressures on the outside and inside of said crucible, and a conduit extending from said crucible to the exterior of said pressure chamber.

3. In combination, in an apparatus for forming spray deposits of high purity aluminum, a crucible composed of substantially pure aluminum oxide, means for heating the crucible, a pressure chamber surrounding said crucible, means for supplying gas under pressure to said chamber, said gas exerting substantially equal pressures on the outside and inside of said crucible, a spray nozzle disposed outside of said pressure chamber, and a conduit composed of substantially pure aluminum oxide extending from said crucible to said spray nozzle and adapted to conduct molten aluminum thereto.

4. In an apparatus for fusing high purity aluminum without contamination, a crucible consisting of substantially pure aluminum oxide, means for heating the crucible, and a conduit consisting of substantially pure aluminum oxide extending from the interior of said crucible to a point of discharge, and means for applying gas pressures above atmospheric pressure to the exterior and interior of said crucible.

5. In an apparatus for producing spray-deposits of high purity aluminum, a crucible consisting of substantially pure aluminum oxide, means for heating the crucible, means for applying pressure to the contents of said crucible, a spray nozzle, and a conduit consisting of substantially pure aluminum oxide extending from said crucible to said spray nozzle.

6. The method of producing spray-deposits of high purity aluminum which includes the steps of melting aluminum of high purity in a crucible consisting of substantially pure aluminum oxide, and conducting the melted aluminum to a spray nozzle through a conduit consisting of substantially pure aluminum oxide.

7. In an apparatus of the type described, the combination of a refractory crucible, means for heating the crucible, and means for discharging molten metal from said crucible at a pressure which would otherwise subject the material of said crucible to destructive forces comprising means for applying fluid pressures above atmospheric to the exterior and interior of said crucible, and a conduit extending from the interior of said crucible to a point of discharge disposed outside of said means for applying fluid pressures.

8. In combination, in a metal spraying apparatus, a refractory crucible, means for heating the crucible, a pressure chamber surrounding said crucible and spaced therefrom, means for increasing the fluid pressure within said pressure chamber, said fluid pressure acting on the exterior and interior of said crucible, a spray nozzle disposed outside of said pressure chamber and a conduit extending from said crucible to said spray nozzle.

9. In an apparatus of the type described, the combination of a refractory crucible, a pressure chamber surrounding said crucible and spaced therefrom, means for increasing the fluid pressure within said pressure chamber, said pressure acting on the exterior and interior of said crucible, and a conduit extending from the interior of said crucible to a point of discharge disposed outside of said pressure chamber.

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