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SEPARATION OF METALS BY DISTILLATION

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This invention relates to a method and apparatus for the separation of metals by distillation and condensation. It is particularly useful in the separation by vaporization and condensation, under controlled conditions of temperature and pressure, of lead, arsenic, antimony, bismuth and other metals from tin or from each other, but it may also be used in the separation of other metals and also of other substances requiring high temperatures for distillation.

In the separation by distillation of metals and other substances requiring very high temperatures to vaporize them, a considerable problem is presented because of the difficulty in finding suitable structural materials to withstand the high temperatures. The permeability at high temperatures of the materials commercially available for such purposes makes the application of high vacuums difficult or impossible with equipment previously available. Also, the fusibility and reactivity of the molten metals or metal vapors with materials with which they contact, present difficult problems in the separation of metals by distillation.

It is an object of this invention to provide an improved method and apparatus for making such separations. It is also an object to provide an improved distillation apparatus for high temperature vacuum distillation. A further object is to provide a method and apparatus in which fractionation of metals by distillation and condensation under vacuum may be carried out continuously. Another object is to provide such a method and apparatus in which the heat necessary to achieve the distillation may be applied to the interior wall of an annular vacuum chamber. An object also is to provide means for accommodating the differences in expansion and contraction of the materials of the apparatus that are subjected to temperature differences of great magnitude. It is also an object to provide means for continuously withdrawing material from the vacuum chamber. Other objects will become apparent.

In utilizing the invention, mixtures of two or more metals in the molten state may be introduced into a chamber maintained under vacuum and flowed over a heated surface of the chamber to vaporize one or more of the metals. A condensing surface also may be provided within the chamber and the condensate and unvaporized residue may be separately collected in the chamber or continuously withdrawn therefrom. The condensing surface is preferably located near the heating surface and uniformly spaced therefrom. In this manner, various metals may be separated continuously from other metals by distillation at relatively low temperatures and without substantial oxidation.

The apparatus should be one that provides a path for the molten metal, etc. of refractory material that will not be adversely affected by or affect the metals, etc. of the molten mixture, within an enclosure of sufficient structural strength and impermeability to withstand the temperatures and high vacuums applied to it during the distillation.

In describing the method and apparatus, reference will be made to the drawings in which several modifications are illustrated, but it is not intended to thereby limit the invention to the particular embodiments shown and described.

The apparatus as illustrated consists essentially of two cylinders having their major axes in a vertical plane and so arranged as to leave an annular space between them within which a vacuum may be maintained. This annular space may be formed by using cylinders of equal length and closing the annular space between them at both ends or the inner cylinder may be made shorter than the outer and the lower end of each cylinder may be closed separately.

The molten mixture of metals to be subjected to the distillation is caused to pass along the heated surface of one of these cylinders and the products of distillation are caused to condense along the cooled surface of the other cylinder, which latter surface is maintained at a temperature sufficiently low to insure the desired condensation. The metal to be distilled is passed into the apparatus in a molten condition through a regulator valve or other suitable feed means. The condensate and the residue from distillation may be withdrawn from the apparatus by means of barometric tubes which discharge into cups, or wells, of molten metal, or by other suitable means, such as pumps.

Referring to the drawings, Figure 1 is a diagrammatic view of a general assembly embodying the invention.

Figure 2 is a vertical cross section along a diameter of an apparatus embodying the invention, the drawing being broken away to indicate greater length.

Figure 3 is a sectional view of the apparatus, taken on the line 3—3 of Figure 2.

Figure 4 is an enlarged fractional, cross sectional view of one of the rings, taken approximately on the line 4—4 of Figure 3.

Figure 5 is a vertical cross sectional view,