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APPARATUS FOR FORMING CORROSION RESISTING FILMS

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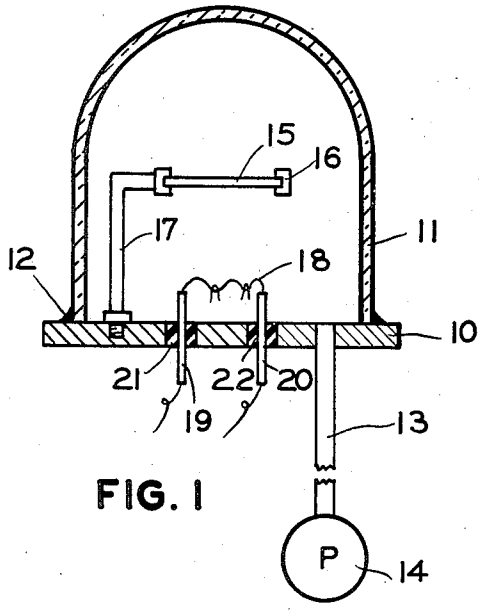


FIG. 1

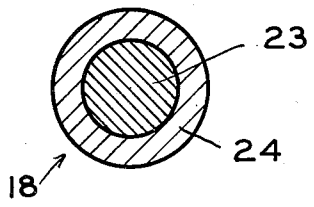


FIG. 2

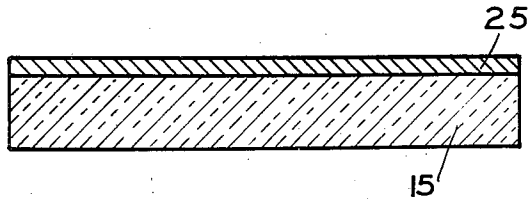


FIG. 3

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APPARATUS FOR FORMING CORROSION RESISTING FILMS

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4 Claims. (Cl. 91—12.2)

This invention relates to an apparatus for forming evaporated film.

It has long been desired to form evaporated films of nickel and certain nickel containing corrosion resisting alloys, as the films of nickel and alloys containing the same are very durable and highly resistant to atmospheric corrosion. This metal and alloys of the same have been difficult to evaporate, for if suspended over a conventional heating filament, generally formed of tungsten, they apparently alloyed with the tungsten and formed low melting point alloys. This caused the portion of the filament contacted by the alloy being evaporated to melt at a temperature below the evaporating temperature of the same, and the filament would break before the alloy could be completely evaporated.

Filaments of high melting point metals other than tungsten have also been tried without success. It has been found that the alloys mentioned seemingly react with filaments of molybdenum, tantalum, platinum and rhodium in a manner similar to their reaction with tungsten.

Attempts have also been made to evaporate such alloys from various containers, such as carbon crucibles or the like, but it was found that it was difficult to heat the nickel and the alloys to the necessary high temperature and furthermore, the materials of the crucibles apparently contaminated the alloys to be evaporated and a non-homogeneous film resulted.

I have found that if the filament is protected by a sheath of metal having an evaporation temperature higher than the alloy to be evaporated, such as rhodium, many nickel containing corrosion resisting alloys can be successfully evaporated.

In the preferred manner of carrying out the present invention, the filament, preferably formed of tungsten, is coated with a relatively heavy film of rhodium. The rhodium may be deposited by any method desired, but in the now preferred method of coacting the filament, the rhodium is deposited on the tungsten wire by means of an electroplating process.

The alloys to be evaporated may be formed into small strips or ribbons and suspended from the filament and evaporated by carrying to completion the usual evaporation process. The resultant film is not only highly resistant to atmospheric corrosion, but to frictional wear as well. Evaporated films of such alloys are substantially neutral when viewed by reflected light, as well as transmitted light when the film is semi-transparent, and for that reason they can be used in many applications in the optical art.

Other objects and advantages of the present invention will appear from the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a sectional view partly in elevation of the apparatus of the present invention.

Fig. 2 is a section of the filament of the apparatus of the present invention on an enlarged scale.

Fig. 3 is a sectional view of an article produced by the apparatus and method of the present invention.

The apparatus of the present invention, referring now to the drawings, is supported by a suitable base plate 10, which carries the evacuable container shown here as a bell jar 11 of glass or other material. A vacuum tight seal is formed between the lower edge of the bell jar 11 and the base plate 10 by any suitable sealing compound 12. The bell jar 11 is connected by any conventional means such as the conduit 13 to a high vacuum pump shown here diagrammatically at 14.

The body 15 having the surface to be coated is mounted in a suitable support 16 carried by a stanchion 17 secured at the lower end thereof in the supporting base plate 10. The body 15, when mounted in the support 16, is superimposed over a filament 18, although the body to be coated may be placed at one side of or even underneath the filament if desired, as the position of the body is determined by convenience. Lead wires 19 and 20, passed through insulated vacuum tight seals 21 and 22, fixed in the base plate 10, connect the heating filament 18 to a surface current which has not been shown in the drawing.

The apparatus just described can be used for evaporating a large number of materials, although very little, if any, success has been had with the evaporation of nickel and many of the nickel containing corrosion resisting alloys with such an apparatus. The nickel as well as the alloys thereof apparently react with the metal of the filament to form low melting point alloys. As the melting point of the resultant alloy was less than the evaporation temperature of the nickel or the alloy to be evaporated, the filament melted and broke at the area contacted by the alloy to be evaporated before the same could be heated to the high temperature necessary to evaporate the same. This has been true of filament metals such as tungsten, platinum, molybdenum and tantalum.

Attempts have also been made to evaporate nickel and its corrosion resisting alloys from crucibles. These attempts have not been successful, as the crucible insulated the material to be evaporated from the heating filament and it was difficult to raise the same to the high temperature necessary. Furthermore, when the metals were heated to a temperature high enough to cause the same to vaporize, the materials of the crucibles used appeared to contaminate the alloys and very unsatisfactory films resulted.

I have discovered that if the filament, preferably formed of a strand of tungsten, is covered with a sheath of metal having a boiling point in excess of 4000° C. but less than 4500° C., such as rhodium, nickel and the alloys mentioned can be successfully evaporated through the conventional high vacuum thermal evaporation process. Although nickel and its alloys will also react with a pure rhodium filament, and form alloys having melting points lower than the temperature necessary to evaporate the same, the rhodium appears to inhibit the alloying action with the tungsten.

Excellent results have been obtained with substantially pure nickel as well as the nickel containing corrosion resisting alloys such as are sold under the following trade-names: Inconel, containing approximately 79.5% nickel, 13% chromium, and 6.5% iron; Nichrome V, comprising substantially 80% nickel and 20% chromium; Chromel, comprising 60–70% nickel, and 15–19% chromium; K-Monel of approximately 66% nickel, 29% copper, and 2.75% aluminum; Invar, containing 36% nickel and 64% iron; Alnico, containing 20% nickel, 63% iron, 12% aluminum, and 5% cobalt; Nichrome, containing 60% nickel, 15% chromium, and approximately 25% iron. It has also been found that certain of the so-called nickel bearing stainless steels can also be successfully evaporated when the rhodium coated tungsten filament of the present invention is used as the heating element. A number of the stainless steels of the group generally designated as 18–8 steels have been successfully evaporated, as well as steels containing as high as 35% nickel.

The rhodium may be deposited on the tungsten strand by any conventional process, although the preferred method is depositing the rhodium thereon by means of an electroplating process. The film of rhodium should be relatively heavy, that is, a mere flash coating is not thick enough to give the protection desired.

Films of the alloys mentioned are relatively hard and consequently quite durable. They are quite resistant to frictional wear if the surfaces coated are subjected to a clean-up glow discharge prior to the deposition of the films. Films of nickel and its alloys are highly resistant to atmospheric corrosion, and are relatively slow to oxidize. Such films are neutral by reflected as well as transmitted light when the film is semi-transparent, and can be advantageously used in many applications in the optical industry.

While certain preferred embodiments of the present invention have been illustrated and described herein, it is to be understood that the invention is not limited thereby but is susceptible of changes in form and detail within the scope of the appended claims.

I claim:

1. In an apparatus of the type described, an evacuable container; means for evacuating said container; and a heating filament for heating a metal to the evaporation temperature thereof while said metal is supported thereby, said filament comprising a strand of tungsten wire coated with a metal having an evaporation temperature higher than the evaporating temperature of said first-named metal for inhibiting the formation of an alloy of said first-named metal and tungsten.

2. In an apparatus of the type described, an evacuable container; means for evacuating said container; and a heating filament for heating a nickel bearing metal to the evaporation temperature thereof while said metal is supported thereby, said filament comprising a strand of tungsten wire coated with a metal having a boiling point in excess of 4000° C. but less than 4500° C.

3. In an apparatus of the type described, an evacuable container; means for evacuating said container; and a heating filament for heating a metal to the evaporation temperature thereof while said metal is supported thereby, said filament comprising a strand of tungsten wire having an outer surface of rhodium.

4. In an apparatus of the type described, an evacuable container; means for evacuating said container; and means for evaporating a metal to cause the same to distill within said evacuated container, said means comprising a heating element of a metal having a relatively high melting temperature coated with a relatively thick film of rhodium.

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