

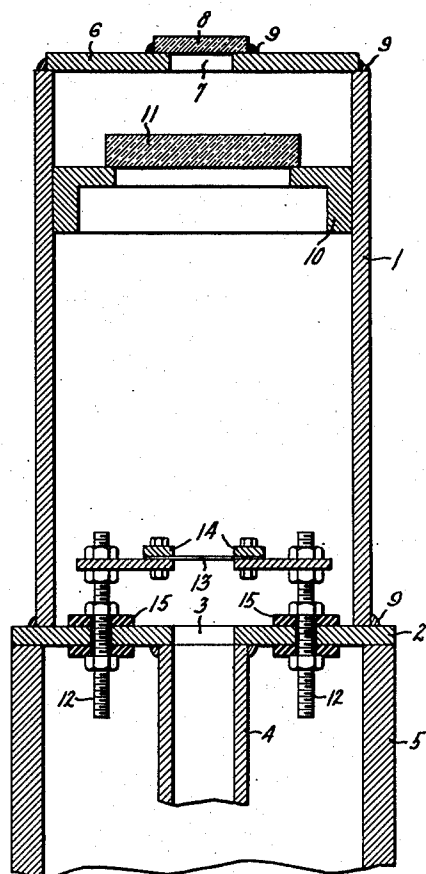
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METHOD AND APPARATUS FOR APPLYING METAL COATINGS

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METHOD AND APPARATUS FOR APPLYING
METAL COATINGSCyril Hubert Walker, Flixton, and Charles Sykes,
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tric Company, a corporation of New YorkApplication March 13, 1935, Serial No. 10,948
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5 Claims. (Cl. 91—70.1)

The present invention relates to an improved method and apparatus for applying metal coatings to surfaces by evaporation distillation of metals in a vacuum to thereby obtain for example astronomical and other reflecting mirrors, electrical condenser sheets such as metal coated paper, which may also be used for low current fuses, and coated textile materials.

The coating of surfaces by evaporation or distillation of metals in vacuum has heretofore been difficult and uncertain owing to the relatively high temperature at which the evaporation took place and owing to the difficulty of obtaining a receptacle or holder for the metal to be evaporated, since by reason of alloying or other chemical action between the metal to be evaporated and said receptacle or holder the latter tends to rot and become unserviceable. It has been difficult to regulate the rate of evaporation or distillation and the results have been both poor and variable, at least from commercial considerations. When an alloy is formed, as is usually the case, between the receptacle or holder and the metal to be evaporated or distilled, the alloy generally has a melting point considerably lower than the evaporation or distillation temperature of the coating metal and even with metals such as tungsten and molybdenum for the receptacle or holder considerable difficulties arise in this respect.

According to the present invention the metal to be evaporated or distilled on to the surface to be coated, and hereinafter called the coating metal, is placed upon the surface of a heater preferably of molybdenum or tungsten and is brought by heating in vacuo into intimate contact with the heater metal without being evaporated or distilled and in such manner as to avoid the formation with the heater metal of an alloy or mixture having a lower melting point than the evaporation or distillation temperature of the coating metal, and thereafter the temperature is raised to cause the coating metal to be evaporated or distilled on to the relatively cool surface to be coated. For best results the vacuum should be high, namely not less than of the order of 10^{-4} or 10^{-5} mm. pressure (mercury column) or lower.

The heater preferably comprises one or a plurality of strips of molybdenum or tungsten held between terminals to which electric heating current can be fed. For the avoidance of the formation of a low melting point alloy the coating metal conveniently can be applied upon said heater strip or strips in the form of thin uniform layers of fine powder namely in such small quantity that any alloy formed has a small percentage of

coating metal, for example not more than about 5 or 10% in the case for example of aluminium on a molybdenum heater. In one particular example, 0.1 gm. of fine aluminium powder was received upon a molybdenum heater strip about 5 inches long, about $\frac{1}{2}$ -inch wide and from 0.005 to 0.01 inch thick, this strip being heated first to a temperature which was estimated at about 900° C. This temperature was preferably maintained until the alloying or mixing was completed whereupon the evaporation or distillation of the aluminium was effected by raising the temperature to what was estimated to be about 1800° C., the coating being apparently completed in about 1 minute. The surface to be coated was 4 inches in diameter and was disposed about 12 or 18 inches above the heater strip in the highly evacuated vessel the lower end of which was connected to continuously operating evacuating pumps maintaining a vacuum pressure of 10^{-4} mm. within the vessel.

For uniformly coating larger surfaces, it will be appreciated, a plurality of distributed heater strips may be employed whilst the surface to be coated is preferably located at a greater distance from the heater provided the vacuum can be maintained adequately high.

With the process according to the invention it is found that the heater strips do not become perforated for a considerable time so that although the strips become brittle they can be used many times particularly as it is unnecessary to remove them from their terminal clamps after each coating operation.

It will be understood that the surface to be coated must be thoroughly cleaned and that the heater strip and other internal parts, including the freshly applied powder should be thoroughly degassed by heating and/or evacuating prior to the actual steps of the process of the invention above set forth. The initial step is preferably carried out comparatively slowly.

Coatings of alloys or mixtures can be deposited by employing two or more heaters carrying respective different coating metals.

The process may be applied to the coating of continuous lengths of paper or fibrous material such as paper or textiles or silk provided the heaters are successively replaced such as by mounting a plurality thereof on a rotating or travelling member.

Articles having thin translucent coatings may be used as light filters by providing only a thin coating.

By the process of the invention beautiful coat-

ings may be obtained, particularly in the case of aluminium the surface of which becomes oxidized to a very small depth, this oxide layer being transparent and protecting the unoxidized coating beneath it against tarnishing. Thus articles or samples of special design for display, such as presentation cups and other silver ware, may be coated with aluminium by the process of the present invention and displayed in show cases or shop windows for many months without tarnishing and thus without any necessity for cleaning or polishing. However the main application of the invention up to date is for astronomical and epidiascope reflectors constituted by glass coated with aluminium.

The novel features which are characteristic of our invention are set forth with particularity in the appended claims. The invention itself however will best be understood from reference to the following specification when considered in connection with the accompanying drawing in which the single figure is a cross sectional view of the apparatus whereby my invention may be carried into effect.

Referring to the drawing 1 is the vessel in which the coating process is carried out. Said vessel is conveniently a hollow steel cylinder. It rests upon a closure plate 2 having a central perforation 3, beneath which is welded a tube 4 connected to evacuating pumps (not shown) which are preferably of the diffusion type employing a switch low vapor pressure oil. The plate 2 which is also conveniently of steel, rests upon a stand indicated at 5. The vessel is closed at the top by a further plate 6, which is preferably provided with a central perforation 7 closed by a glass window 8. Vacuum joints such as indicated at 9 may be effected by a suitable grease or wax, or at least the joint such as between the plate 6 and vessel 1 which is required to be made and broken frequently for the insertion of articles to be coated and of the coating powder, may be formed by a suitable wax or grease, whilst other joints may be made more permanent such as by welding or by bitumen.

Fixed in the upper portion of the tube 1 and preferably adjustable therein as to height is the support 10 for the member indicated at 11 to be coated, which may be a glass disc for instance.

The lower closure plate 2 is provided with at least two further perforations through which pass the lead-in and support screws 12 for the heater strip 13 which is held at its end in clamps 14 secured to the upper ends of the members 12, which are, of course, insulated from the plate 2 through which they pass in a vacuum type

manner such as may be obtained by the insulating washers 15. In practicing the method, the electric current is increased until the coating metal powder appears to melt as may be seen through the window 8 and through the article 11 (assuming the latter is transparent). This step should be carried out slowly, care being taken not to raise the temperature too high, as can be controlled by viewing the glowing strip. Thus the temperature can be raised considerably until the coating metal boils off the strip and deposits upon the article 11 until the coating is of sufficient thickness as can be controlled by observing the reduction in transparency of the article, whereupon the current may be switched-off. It is found that the coatings are fully annealed, and if sufficiently thick can be peeled off the article.

It will be understood that the process hereinbefore set forth is susceptible to minor variations whilst the apparatus shown in the drawing may be considerably modified, all within the scope of the invention.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. The method of applying metal coatings to surfaces by evaporation or distillation in a vacuum, which consists in placing the coating metal upon the surface of a metal heater, which is preferably electrically heated molybdenum or tungsten, heating said coating metal to its melting point in a vacuum to thereby bring it into intimate contact with the heater metal, the quantity of coating metal employed being so small that any alloy formed with the heater element has a higher melting point than the evaporation or distillation temperature of the coating metal, and thereafter raising the temperature to cause the coating metal to be evaporated or distilled on to the relatively cool surface to be coated.

2. The method as claimed in claim 1, wherein the vacuum is maintained at a pressure of 10^{-4} mm. mercury column or lower.

3. The method as claimed in claim 1, wherein the coating metal is placed on the heater surface in the form of thin uniform layers of powder.

4. The method as claimed in claim 1, wherein the heater is in the form of a strip.

5. The method as claimed in claim 1, wherein the heater is located in the base of an evacuable vessel in which the article to be coated is supported above the heater.

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