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W. H. COLBERT ET AL  
PROCESS OF EVAPORATING METALS  
Original Filed May 27, 1944

2,432,657

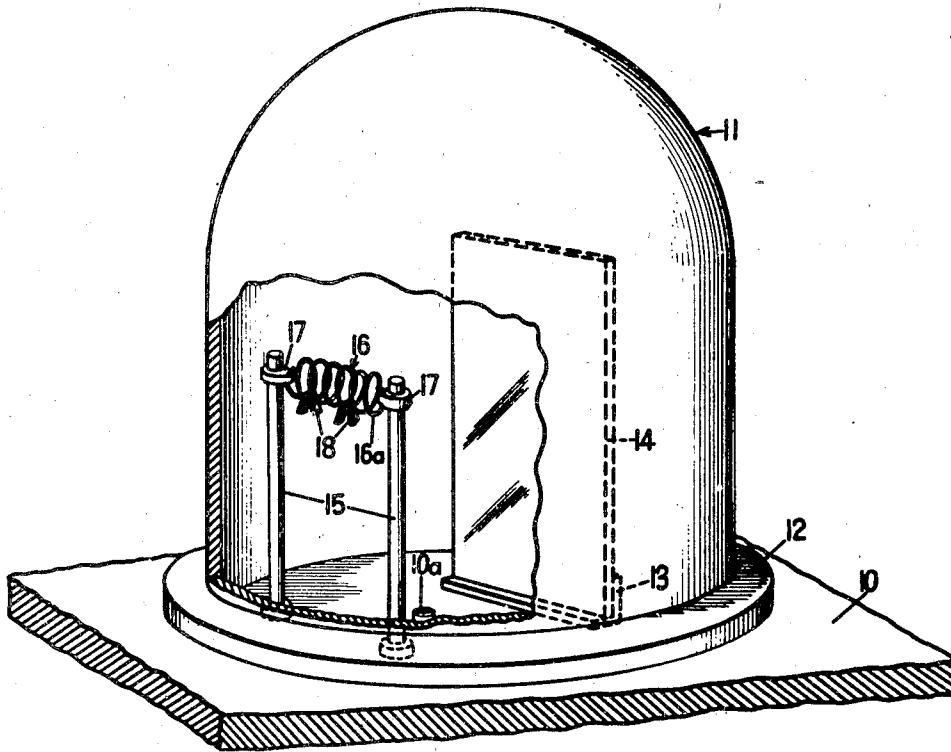


Fig. 1

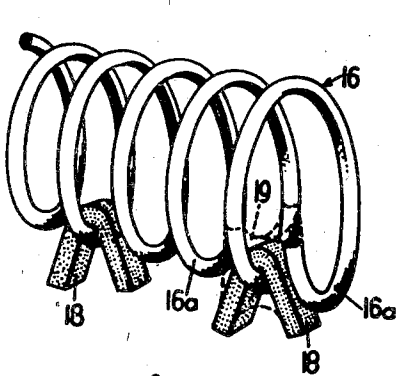


Fig. 2

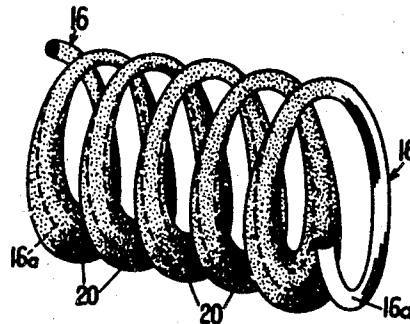


Fig. 3

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## UNITED STATES PATENT OFFICE

2,432,657

## PROCESS OF EVAPORATING METALS

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Original application May 27, 1944, Serial No.  
537,675. Divided and this application August  
14, 1946, Serial No. 690,358

9 Claims. (Cl. 117--107)

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Our present invention relates to a novel process of evaporating metals. It has to do, more particularly, with the coating or wetting, by capillary attraction, of a filament which, for example may be formed from a coil of ordinary tungsten wire, tantalum, molybdenum or columbium wire, by various metals in the form of an alloy or different alloys, which metal or metals it is desired to evaporate and which in pure form normally do not wet these metallic filaments, and the application of said metals or metal alloys by deposition resulting from thermal evaporation, to the face or surface of an article, such as a piece of glass, porcelain, plaster, metal, plastic, Cellophane, paper or the like, to provide a reflective or metallized surface coating for said article. The invention also has to do with securing wetting and with thermal evaporation of such metals from pure tungsten, tantalum, molybdenum, or columbium filaments by alloying such filaments by the application to the filaments of the metals desired to be evaporated alloyed with and carrying the elements which we have found it desirable that the filaments be alloyed with. This application is a division of our copending application Serial No. 537,675, filed May 27, 1944. The said application has now matured into Patent No. 2,413,604 and is dated December 31, 1946.

Methods and apparatus have previously been employed to apply coatings of metals by thermal evaporation to the faces or surfaces of such articles to produce mirrors, reflectors or metallized materials for other purposes. In these methods it is desirable to effect the thermal evaporation of the metal, such as silver or aluminum, by applying the metal directly to an electrically energized and thus heated tungsten or other metallic filament which is preferably located within a vacuumized chamber. The metals which may be used as filaments for such evaporations must obviously be of high melting point and also of low vapor pressure at the elevated temperatures at which the metals applied to the filaments evaporate. Thus, tungsten, tantalum, molybdenum and columbium have represented the only practical materials for such use. Platinum also has been used to a small degree but its high cost is generally prohibitive. While iron and nickel are

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of relatively low vapor pressure, they are of such relatively low melting point that filaments made from them rapidly burn out.

With these filaments many of the metals can be readily evaporated. Thus, for example, aluminum, beryllium, magnesium, vanadium, barium, strontium, iron, nickel, cobalt, manganese, thorium, chromium and titanium, when applied to filaments of tungsten, tantalum, molybdenum or columbium, will on heating in a vacuum, melt and spread over the filament by capillary attraction and satisfactory evaporation of these metals then occurs from the large amount of surface which the molten metal covers.

However, with a large number of metals which it is desirable to be able to thermally evaporate and which from their vapor pressure at elevated temperatures should readily evaporate, it has been found difficult, if not impossible, to carry out satisfactory deposition of such coatings by thermal evaporation. Thus, for example, silver while readily lending itself to thermal evaporation from a crucible, cannot be evaporated readily from a coil of tungsten, tantalum, molybdenum or columbium when applied to a filament of these metals and heated by electrical resistance. The silver on melting shows no affinity for the metallic filaments and almost immediately after melting collects into a drop and falls off the filament. This lack of ability to wet tungsten, tantalum, molybdenum and columbium occurs also with the metals copper, gold, zinc, tin, antimony, cadmium, bismuth, lead, thallium and indium. With each of these metals the use of the four available coil filaments as a means of evaporating these metals has not been possible, and less desirable means of heating have been necessary where it became necessary to evaporate these under practical conditions repeatedly in the commercial production of mirrors and metallic coated articles. As each of these metals, after melting, pulls together into droplets and falls off the filaments, there has resulted a wastage of the metal whenever it has been attempted to evaporate them from these filaments and there have been continuous failures of the apparatus to function due to the loss of the metals from the heated wires; and where any metal has been evaporated the amounts so

evaporated have always been uncertain and without control.

We have found that we may use tungsten, tantalum, molybdenum or columbium as filaments for the evaporation of metals which do not wet these filaments by causing them to wet such filaments by the application to such filaments, or the forming thereon, of alloys of these metals which we desire to evaporate with another metal which is characterized in that it will also form an alloy with tungsten, tantalum, molybdenum and columbium in the presence of the metal we desire to evaporate. As metals which we have found which may be used in a relatively small quantity which cause the normally non-wetting metals to wet the metallic filaments we may use iron, nickel, cobalt, platinum or palladium, or several of these together. Thus, for example, we may add small amounts of nickel to silver and when such alloys are melted on a tungsten filament the silver will be found to wet the tungsten filament and to spread itself by capillary attraction over the surface of the tungsten wires. In the absence of the nickel the silver melts, draws itself into a droplet and falls off the filament wire because it does not wet the same. Not all metals have been found to act in this manner. Alloying the normally non-wetting metals among themselves, such as adding lead to silver, does not seem to bring about any desirable improvement in the wetting characteristic. In each case it is found that the metals of the iron group, namely, iron, nickel and cobalt and the metals of the platinum group, namely palladium, platinum, rhodium and iridium readily form alloys with tungsten, tantalum, molybdenum and columbium and also form alloys with copper, silver, gold, zinc, tin, antimony, cadmium, bismuth, lead, indium and thallium. Thus, the metals of the iron and platinum groups which we have enumerated readily bring about the desired wetting and it appears clearly that this is accomplished through the mutual alloying tendency which these metals possess.

One of the objects of our invention is to provide an improved and satisfactory method or process of evaporating metals which normally do not wet heater filament coils of tungsten, tantalum, molybdenum, or columbium, by alloying the metal so as to cause the metals to wet the coils of such filaments and to coat the coils by capillary attraction so that thermal evaporation can then be carried out.

Another object of our invention is to apply to a tungsten, tantalum, molybdenum or columbium filament a metal to be evaporated which does not wet such filament coils, alloyed with a suitable proportion of another metal of the iron or platinum groups which alloys with the filament and brings about a proper wetting or coating of the filament wires by capillary attraction under the influence of heat applied to the filament.

As another object of our invention there is provided an improved method or process whereby a metal which is to be evaporated and which does not normally wet heater filaments of tungsten, tantalum, molybdenum and columbium is alloyed with another metal such as platinum, palladium, nickel, cobalt or iron, and applied to such a filament, or in which a suitable alloy consisting of one or more of these metals with the metal to be evaporated is applied to such filaments, and by securing a wetting and coating of the filament by capillary attraction of the metal desired to be evaporated may be deposited upon the face or

surface of an article, by thermal evaporation, to provide such article with a reflective or metallized surface coating.

As a further object of our invention there is provided an improved method or process whereby a metal desired to be evaporated to form a reflective surface coating is applied to a tungsten, tantalum, molybdenum or columbium filament as an alloy with another metal whose vaporizing temperature is higher and which metal brings about a wetting and coating of the filament by capillary attraction, thus permitting the deposition of the desired metal upon the face or surface of an article by thermal evaporation without appreciable evaporation of the added metal so as to give a reflective surface coating showing the characteristic properties of the desired metal only. The alloy element may also be alternatively used in the filament to secure the same objectives, as set forth in our copending application, Serial No. 537,676, filed May 27, 1944. The said application has now matured into Patent No. 2,413,605 and is dated Dec. 31, 1946.

A further object of our invention is to apply to a tungsten, tantalum, molybdenum or columbium filament, a metal such as copper, silver, gold, zinc, tin, antimony, cadmium, bismuth, lead, indium or thallium, alloyed with a suitable proportion of another metal which brings about a desirable wetting or coating of the filament metal by capillary attraction under the influence of heat applied to the filament and thus permits thermal evaporation of the metals.

Generally speaking, and in accordance with our present invention, the metal to be evaporated which normally does not wet the heater filament is applied alloyed with another suitable metal providing wetting characteristics to the coils of a filament which may be formed from tungsten, tantalum, molybdenum or columbium. Thus, in order to thermally evaporate copper, zinc, gallium, or arsenic, which are metals of the chemical periodic table arrangement found in series 5 or the metals silver, cadmium, indium, tin and antimony, which include metals of series 7, or the metals gold, thallium, lead and bismuth which in the periodic arrangement include series 11, all of which metals do not wet filaments made of tungsten, tantalum, molybdenum or columbium, we first bring about a satisfactory wetting and adhesion of these metals to the filaments by applying the metals to the filaments as an alloy with small amounts of another metal either selected from the iron group such as iron, nickel or cobalt, or selected from the platinum group metals such as platinum, palladium, rhodium or iridium, and then by energizing the filament and thus heating it we cause a melting of the metals. It is, of course, well known that the metals copper, silver, and gold constitute a family in the chemical periodic table arrangement. When the applied metal alloys are thus melted they apparently alloy to some degree with the metal comprising the heater filament wire and by reason of such tendency the molten metals wet the filament wires and by capillary attraction are drawn out over the surface of the coils. The molten metal which has thus covered considerable surface of the heated coil and is held thereto by capillary adhesion is thereafter evaporated uniformly from the heater coils to apply a surface coating of a metallic or reflective nature to an article such as a piece of glass, porcelain, silica, mica, plastic, metal, Cellophane, resin, or other support material, by deposition resulting from the

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thermal evaporation of the metal from the filament. The operations of thermal evaporation may with some of the metals, be carried out at normal pressure but generally are preferably carried out in vacuum chambers known to the art and within a high vacuum, which may be of the order of one millimeter down to 10 to the minus 5 millimeters or better. It is very necessary that the metal to be evaporated wet and coat the coil surfaces in order that the metal will evaporate uniformly in all directions. By securing such wetting action the thermal deposition of these metals, in addition to being made possible, has been found by our process to give uniform coatings.

As will be shown more fully later, pieces of the metal to be evaporated and which have been previously alloyed with the metal which brings about the alloying with and wetting of the filament, may be hung onto the loops or coils of the filament.

The foregoing and other objects and advantages of the present invention will appear from the following description and appended claims when considered in connection with the accompanying drawings forming a part of this specification wherein similar reference characters designate corresponding parts in the several views.

In said drawings:

Figure 1 is a perspective view, partly broken away, illustrating one suitable apparatus for carrying out our improved method or process.

Figure 2 is a perspective view of a fragment of an electric filament showing the application of a suitable metal alloy to several of the coils or convolutions thereof, and illustrating one phase of the method or process of wetting or coating the filament by said alloy; and

Figure 3 is a view similar to Figure 2 showing the filament after the completion of the wetting process by the alloy of Figure 2.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. It is to be understood also that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention herein claimed beyond the requirements of the prior art.

Referring now to the drawings, we have shown a suitable apparatus for carrying out our improved method or process, as well as one suitable metal alloy and the steps of applying the alloy or a filament by a wetting action resulting from capillary attraction.

Suitable apparatus employed by us, and illustrated in Figure 1, comprises, as shown, a supporting base 10 upon which is mounted a housing, shown as a hole at 11. The housing 11 may be in the form of a bell-jar or the like having a dome-like or semi-spherical top portion or enclosed end and a bottom open end having a surrounding flange or projection 12 which is adapted to rest upon the top face or surface of the supporting base 10.

Within the chamber provided by the housing 11, we have shown a suitable work-piece support 13 for supporting a work piece, such as a plate or piece of glass, plastic, plaster, paper, porcelain, metal, or the like 14, in upright position.

Located within the chamber and mounted upon

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the supporting base 10, is a pair of upright supporting posts 15 between which is carried or supported, in substantially horizontal position, an electric filament 16. The filament, as shown, is in the form of a coiled wire made of tungsten, molybdenum, columbium or tantalum whose opposite ends are attached to brackets 17 mounted upon the supporting posts 15 and adjustable thereon so as to vary the position or location of the filament 16 with relation to the supporting base 10.

The chamber provided by the housing 11 may, if desired, be completely evacuated of air through outlet pipe or conduit 18a and have a high vacuum created therein by means of suitable air evacuating and vacuum creating means, such as a pump (not shown).

In accordance with one method embodying our invention which is to be performed or carried out within the chambered housing 11, we preferably provide a metal alloy which may consist of silver, copper or gold or other normally non-wetting metal and approximately 5 to 15% or more of platinum. Pieces of this preformed silver and platinum alloy, or copper and platinum alloy, or gold and platinum alloy, several of which are shown at 18, in Figures 1 and 2, are bent and hung on the loops or convolutions 16a of the filament 16 in the manner shown.

It is known that silver, copper and gold lend themselves admirably to thermal evaporation but they have no wetting affinity for tungsten, tantalum, molybdenum or columbium surfaces and therefore silver, copper or gold alone is unsatisfactory for coating the filament 16 formed from either of these metals by a wetting action effected by capillary attraction. Wetting of the filament wire is essential to secure a maximum of evaporating surfaces to provide evaporation uniformly in all directions, to the securing of uniform deposits, and also to avoid the dropping of the molten metal off the heater wires. We have found that platinum, while having a higher melting point than gold, copper or silver, readily alloys with silver, gold and copper and the alloys have a wetting affinity for the four above-mentioned metals, any one of which may be used for making the filament 16, and thus platinum lends itself particularly well to securing the wetting of the filament by capillary attraction. Therefore, by including a certain percentage of platinum, preferably 5% or more, with the silver, copper or gold to form the alloy 18, the platinum will serve to bring about wetting or coating of said filament by the molten metal by capillary attraction when the filament is energized and thus heated and will act to cause the silver, copper or gold to also cling to or wet the filament. An early stage or phase of the wetting action of the filament 16 by the alloy 18 is shown generally at 19, Figure 2. As the wetting action by capillary attraction continues, the two metals of the alloy will proceed to wet the coils of the filament 16 and in fact, will substantially wet or coat and cover the surfaces of the filament. In Figure 3, we have illustrated several of the coils or loops 16a of the filament as being coated at 20 by the alloy from which the pieces 18 are formed.

Thus, by including platinum with the silver, copper or gold, as an alloy, it is possible to quickly and effectively coat or wet the filament 16 by capillary attraction. Since, therefore, the alloy builds up onto the surfaces of the filament in substantially the manner illustrated in Figure 3, there will be a relatively uniform coating or wetting of

the filament and a uniform dependable evaporation of the silver, copper or gold. Heretofore, when attempts were made to wet the filament by the use of the silver, the copper or the gold alone, only small portions of the molten metal would cling to the filament as droplets hanging from the lower ends of the coils of the filament, with the major portion of the molten metal dropping or falling off the coils. This was particularly undesirable since it was practically impossible to produce, by thermal evaporation, an even surface coating by deposition, or to control the deposition to desired coating deposit thicknesses on the surface of an article, such as the article 14, to which it was desired to apply a reflective surface coating. By virtue of the fact that the silver, copper or gold did not properly wet the tungsten or other metal filament but had a tendency to drop off said filament, the process of coating with these metals by deposition was unsatisfactory, slow and painstaking because only a small portion or percentage of the filament received the metal coating. Considerable shutting down and starting over again was required when most of the gold, silver or copper on first melting dropped off the coils and no evaporation was secured. Thus, great waste occurred, the process was considerably slowed down, and the coating produced by deposition, if any, was uneven or spotty and unsatisfactory because of such uneven character thereof on the surface of the article coated. Commercial production under such uncertain conditions was impossible.

It is to be understood that in carrying out our method or process as described above, in the chamber of the housing 11, the chamber, depending upon the metal being evaporated, may be at atmospheric pressure, or it may be evacuated of air and a vacuum created therein. Thus, after the pieces 18 of the silver and platinum alloy or copper and platinum alloy or gold and platinum alloy, as the case may be, have been applied to the coils of the filament 16 and the work piece 14 mounted upon its support 13 within the chamber, a vacuum of 10 to the minus 3 millimeters or better, is created and the filament 16 is then energized and therefore heated so as to melt the alloys and to start in motion the wetting action of the filament by capillary attraction, as explained above. After the wetting action has been completed as illustrated generally at 20 in Figure 3, the filament 16 is further energized to increase the heat therein, whereby silver, copper, or gold in the coating 20 of the alloy will be thermally evaporated and transferred by deposition to the face or surface of the work piece 14 which, as shown, is disposed in a position opposite the filament 16. The platinum does not evaporate at the temperatures required to evaporate the gold, silver or copper and the reflective deposits produced in such cases are of reflective values and otherwise similar to gold, silver and copper mirrors made by evaporating these metals alone from crucibles within a high vacuum.

In a similar way pieces of a preformed alloy of silver with 5 to 15% or more of palladium may have been applied to the heater filament coils of tungsten, tantalum, molybdenum or columbium and on heating such coils the alloy melts, wets the filaments, and thereafter in a vacuum the silver evaporates off the filament onto the article to be coated and produces a silver mirror of 95 to 98% reflection thereon. The palladium all remains with the filament. Alloys of copper

and 5 to 15% or more palladium are similarly useful in preparing copper mirrors and the copper deposits in their reflectivity and color show that no palladium is carried over. Palladium alloys with the other non-wetting metals cause these to wet the filaments desirably.

We have found that using a mixture of platinum and palladium, such as 5% to 10% of each in alloy with either silver, copper or gold, gives equally as good wetting action as is secured with either alone.

We have also found on the other hand, that if, for example, the loops 18a of an electric filament or coil 16, such as that shown in Fig. 2, were to have applied thereto pieces of pure silver, or of pure copper, and relatively smaller pieces of some suitable wetting and carrier metals, such as platinum or nickel, that when the coil or filament is energized and thus heated, whereby to cause a melting of the metals, the molten metals generally drop off the loops before sufficient alloying of these, and alloying and a wetting of the surfaces of the filament occurs, and that the results are uncertain and losses of evaporations and materials and time occur. This is always the case with the low melting metals such as zinc, cadmium, tin, lead and indium, which non-wetting metals melt quickly at low temperatures and fall off the heater wires or filaments before any appreciable solution or alloying with the higher melting iron or platinum metals occurs. Consequently, with all of the metals we find it necessary and desirable to start with a pre-formed alloy.

The iron metals are particularly active in alloying with tungsten and tantalum and the alloys produced are of much lower melting point than is true of the pure tungsten or tantalum. Consequently, we have found that where we apply pieces of iron, cobalt, or nickel to such filaments along with the metals to be evaporated, or use these as fine wire windings around such metals, that upon heating the filaments, the iron metals cause rapid melting through the filaments and breakage of the same which stops or interrupts the attempt to carry out a thermal evaporation.

Thus we find it necessary to utilize preformed alloys and with iron, cobalt or nickel, we use preferably 5% or less, by weight, in the alloys with the metal to be evaporated as, for example, silver, and a weight of such metals as low as 0.5% may often effectively be used to bring about satisfactory wetting of the filaments. Thus, in evaporating silver or copper by the use of an alloy of either with either nickel or iron, we have used alloys very satisfactorily which wet the filaments uniformly in which there was 1% to 2%, by weight, of iron or nickel present on the weight of the silver or copper.

The use of our metals such as platinum, palladium, iridium or rhodium to bring about a satisfactory wetting and evaporation has been particularly attractive in that when used with the metals which it has been desired to evaporate, these metals, platinum, palladium, iridium and rhodium have not appreciably evaporated so that the deposits of silver, copper, tin, lead or other metals have been secured essentially pure and as mirrors they have shown the full normal reflectivity and colors characteristic of pure mirror deposits of these metals. Thus, with silver 95% reflection value mirrors may be readily secured when using palladium or platinum with the silver. From the following table of temperatures at which the vapor pressure of the different metals is 0.01

millimeters, it is apparent that, as these are also the boiling or evaporating temperatures in a vacuum of this pressure, there is negligible chance of contamination of the metal deposits with the platinum metals since the vapor pressures of these are negligible below 2000° C. at which the various elements under consideration would evaporate. On the other hand, the use of iron, nickel, or cobalt in the evaporation of gold, copper or tin might be expected to give mirror deposits containing some iron, nickel or cobalt. Moreover, iron, nickel, or cobalt can be used in the thermal evaporation of antimony, bismuth, zinc and cadmium without their contaminating the mirror deposits secured.

| Metal           | Temperatures at which metal boils |                                        | Melting point |
|-----------------|-----------------------------------|----------------------------------------|---------------|
|                 | At 0.01 mm. Pressure              | At 760 mm. normal atmospheric pressure |               |
|                 | ° C.                              | ° C.                                   | ° C.          |
| Cadmium.....    | 268                               | 780                                    | 321           |
| Zinc.....       | 350                               | 930                                    | 419           |
| Bismuth.....    | 640                               | 147                                    | 271           |
| Antimony.....   | 700                               | 1,380                                  | 630           |
| Lead.....       | 727                               | 1,800                                  | 327           |
| Tin.....        | 975                               | 2,260                                  | 232           |
| Chromium.....   | 917                               | 2,200                                  | 1,615         |
| Silver.....     | 1,046                             | 2,040                                  | 960           |
| Gold.....       | 1,172                             | 2,600                                  | 1,063         |
| Aluminum.....   | 1,188                             | 1,800                                  | 669           |
| Manganese.....  |                                   | 1,900                                  | 1,260         |
| Copper.....     | 1,269                             | 2,300                                  | 1,083         |
| Iron.....       | 1,421                             | 3,000                                  | 1,535         |
| Nickel.....     | 1,444                             | 2,900                                  | 1,452         |
| Cobalt.....     |                                   | 2,900                                  | 1,490         |
| Platinum.....   | 2,059                             | 4,300                                  | 1,755         |
| Palladium.....  |                                   | 2,200                                  | 1,555         |
| Iridium.....    |                                   | 4,400                                  | 2,440         |
| Rhodium.....    |                                   | 2,500                                  | 1,985         |
| Tantalum.....   |                                   | 4,100                                  | 2,850         |
| Tungsten.....   | 3,232                             | 5,900                                  | 3,370         |
| Molybdenum..... | 2,482                             | 3,700                                  | 2,620         |
| Columbium.....  |                                   |                                        | 1,950         |

A further advantage of very practical importance in the thermal evaporation of the various metals has been secured through our securing good wetting of the filaments in that the metals being evaporated show very little explosive boiling or spitting which by reason of small chunks of metal blown over onto the article being coated has caused spoilages. This appears to have been accomplished by the decrease of surface tension forces accompanying the wetting and also in the elimination of conditions leading to super-heating by getting the metal to spread out in a thin coating over most of the filament surfaces.

From the foregoing it will be seen that we have provided an improved method or process for applying certain metals to a filament of tungsten, tantalum, molybdenum or columbium by causing a wetting resulting from capillary attraction through the application of other metals and applying heat from the filament, and have thereby been able to carry out evaporation of such metals after the wetting action has been completed by thermally evaporating the metals and have caused their deposition upon the face or surface of a work piece to provide metallized or reflective surface therefor. It will also be seen that while we secure the desirable requisite of wetting of the filaments of tungsten, tantalum, molybdenum or columbium, by metals which normally do not wet these, by the use of a platinum group or iron group metal this may be accomplished in several ways. Thus, we may apply separate pieces of a preformed alloy of such metals with one of our platinum or iron group metals and these will wet the pure metallic filaments.

While we have referred to the use of tungsten, tantalum, molybdenum, or columbium as suitable metals from which the coiled filament or element 16 may be formed, other suitable metals may be used for this purpose. We have mentioned these metals particularly since their high melting points and low vapor pressures at the boiling temperatures of other metals as shown in the above table make these the practically desirable metals for use as such filaments.

We have described our improved method or process as preferably being carried out in a vacuumized chamber in which the step of wetting the filament takes place, as does also the step of thermal evaporation of the metal to effect its deposition upon the work piece to provide a reflective coating thereupon.

Obviously also in the case of the most readily volatile metals, such as cadmium and zinc, the melting of the metals and the wetting of the filaments, as well as the evaporation of the readily volatile metals, such as cadmium or zinc, may be carried out under atmospheric conditions of pressure if desired, while employing a suitable inert atmosphere.

Having thus described our invention, what we claim is:

1. The method of producing coatings by evaporation of silver from a filament selected from the group consisting of tungsten, tantalum, molybdenum and columbium, wherein the silver is alloyed with a metal selected from the group consisting of iron, cobalt and nickel, and is heated on said filament and wherein said metal causes the silver to wet, to adhere to, and to spread out over the filament surfaces and by the continued application of heat, to evaporate and to deposit upon an article to be coated.

2. The method of producing coatings by evaporation of a metal of the silver chemical periodic table family from a filament selected from the group consisting of tungsten, tantalum, molybdenum, and columbium, wherein the metal to be evaporated is alloyed with a metal selected from the group consisting of iron, cobalt and nickel and is heated on said filament, and wherein said selected alloying metal causes the metal desired to be evaporated to wet, to adhere to, and to spread out over the filament surfaces and by the continued application of heat, to evaporate and to deposit upon an article to be coated.

3. The method of producing coatings on articles by evaporation of silver from a filament selected from the group consisting of tungsten, tantalum, molybdenum and columbium, wherein the silver is alloyed with nickel and is heated on said filament and wherein said nickel causes the silver to wet, to adhere to, and to spread out over the filament surfaces and by the continued application of heat, to evaporate and to deposit upon the article to be coated.

4. A method according to claim 3 wherein copper is substituted for the silver.

5. A method according to claim 3 wherein gold is substituted for the silver.

6. A method according to claim 3 wherein the nickel is present in amounts less than 5% by weight.

7. A method according to claim 1 wherein said metal is present in amounts ranging approximately from 0.5% to 5% by weight.

8. A method according to claim 3 wherein the nickel is present in amounts of approximately 1% to 2% by weight.

9. A method according to claim 2 wherein the

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alloying metal is iron and is present in amounts of approximately 1% to 2% by weight.

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