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METHOD OF PLATING METAL WITH MAGNESIUM

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Fig. 1

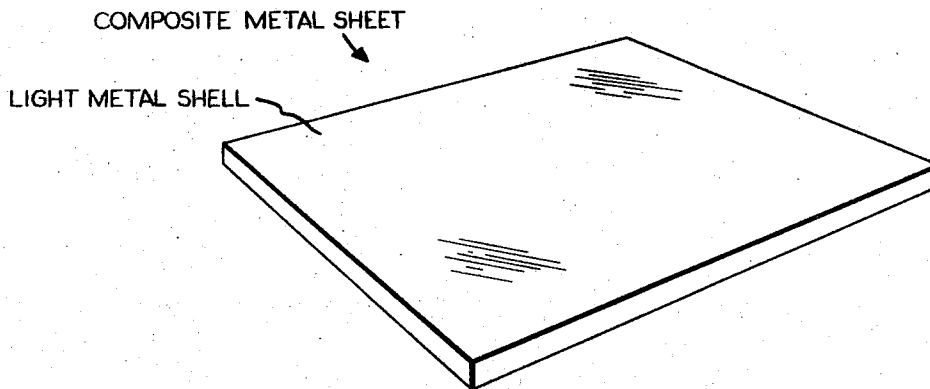


Fig. 2

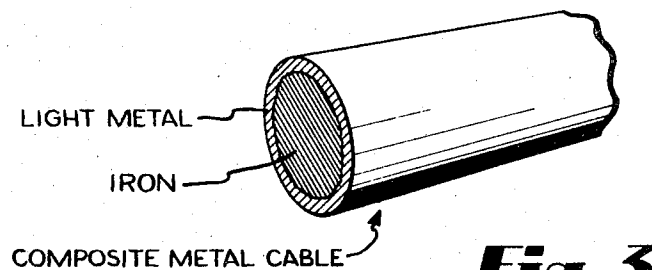
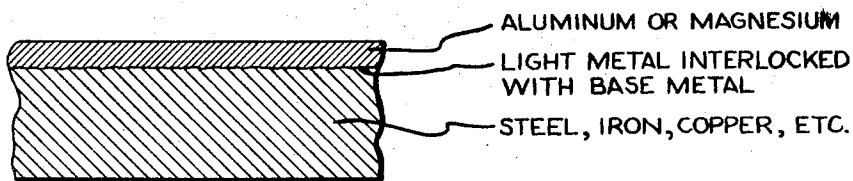


Fig. 3

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METHOD OF PLATING METAL WITH MAGNESIUM

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2 Claims. (Cl. 117—107)

This invention relates to methods of gas plating light metals such as magnesium, aluminum or the like, on metal surfaces to form composite metal bodies.

It has been attempted heretofore to form composite articles of various metals and light metals such as magnesium and aluminum, but it has not been successful without the use of intermediate bonding layers. This has been resorted to because of the weak bond produced between these light metals and the metal surfaces on which they are applied. This is due largely to their great affinity for oxygen. The present invention is designed to overcome these difficulties for all practical purposes, and provide a method of plating these light metals onto different metal surfaces.

In accordance with the present invention, aluminum or magnesium metal, or suitable mixtures thereof are deposited directly upon a substratum which may be composed of metals such as steel, iron, copper, magnesium, aluminum, or metal alloys to provide a tenaciously bonded metal layer or coating of light metal. The process thus avoids the necessity of utilizing an intermediate bonding layer as has heretofore been the practice.

The principal object of the present invention is to apply a light metal such as aluminum or magnesium directly onto a base metal including aluminum and magnesium and alloys thereof, whereby the same is provided with an outer shell or portion formed substantially of pure aluminum or magnesium.

Another object of the invention is to provide a composite metal article consisting of a substratum of light metal and an outer coating or layer of aluminum metal.

Another object of the invention is to provide a composite metal article of the character described, which comprises a gas plated layer of aluminum metal or magnesium metal.

Another object of the invention is to provide a method whereby light metal, such as magnesium and aluminum, may be plated onto metal castings, sheets, strips or the like and fabricated into a wide variety of products and shapes, and where it is desirable that the article have an outer portion composed of light metal.

Another object of the invention is to provide a method whereby metals such as steel, iron, copper and the like may be suitably protected with a layer of aluminum metal, the same being deposited directly onto the substratum.

Another object of the invention is to provide a method of tenaciously uniting aluminum or magnesium metal to a supporting base metal without the necessity of employing an intermediate bonding layer or alloy as has been the practice heretofore.

Another object of the invention is to provide an improved method of gaseous metal plating these light metals of Group II and III of the Periodic System onto the surfaces of articles by gaseous metal plating.

It is still another object of the invention to provide a method for producing aluminum coated articles whereby aluminum metal is deposited onto the surface of the substratum and into the pores and interstices of the surface

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to provide an interlocked substantially integral layer or coating of aluminum metal thereon.

These and other objects and advantages will become apparent as the description proceeds.

In the drawing:

Figure 1 is a perspective view of a composite metal sheet incorporating the teaching of this invention.

Figure 2 is a cross section view of the composite metal sheet shown in Figure 1.

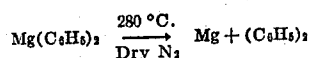
Figure 3 is a view in perspective and cross section of a composite metal cable incorporating the teaching of this invention.

In accordance with the present invention, metal surfaces such as magnesium, aluminum, steel, iron, copper and the like, and alloy metals are cleaned to remove foreign matter and then subjected to gas plating utilizing a suitable heat-decomposable organometallic compound of aluminum or magnesium, or suitable mixtures thereof, to provide a finished composite metal product.

The following examples are illustrative of how the invention may be practiced but are not intended to be restrictive of the invention.

Example I

Magnesium metal casting sand blasted to provide a clean surface is heated to about 350° C.—400° C. in an atmosphere of dry helium containing magnesium diphenyl. This magnesium organometallic compound decomposes at about 280° C. disassociating into magnesium and diphenyl. The process is carried out under atmospheric pressure conditions and in the absence of moisture to avoid fire hazard. In this instance the deposition of magnesium may be according to the equation:



Example II

Magnesium sheet metal is gas plated with magnesium metal similarly as in Example I, but under sub-atmospheric pressure conditions of from 18–25" mercury, and using dry nitrogen as the inert gas carrier for magnesium diphenyl.

Example III

In this instance steel strip material previously freed of foreign matter is heated to 350° C. and contacted with an atmosphere of dry helium containing magnesium diethyl, and under sub-atmospheric pressure conditions as in Example II. Upon decomposition of the magnesium alkyl compound magnesium is deposited onto the surface of the steel.

Example IV

Iron castings are gas plated with magnesium as in Example III employing methylmagnesium iodide which thermally decomposes at about 250° C.

Example V

Magnesium metal is gas plated on steel as in Example III using triarylmethylmagnesium iodide and at plating temperatures to bring about thermal decomposition of the iodide in an atmosphere of dry inert gas, e. g. nitrogen.

Example VI

In this instance a 50–50 weight mixture of aluminum triethyl and magnesium diethyl was used and the gas plating being carried out on steel strip as in Example III. In this case an alloy coating of magnesium and aluminum is plated onto the steel strip, the temperature being raised to bring about disassociation of the mixture of organometallic compounds and deposition of the metal constituent.

Example VII

Copper plate is cleaned and heated in an atmosphere of helium at a temperature of about 385° C. and in which is introduced approximately 10% of aluminum trimethyl. This compound boils at about 135° C. and is caused to disassociate to deposit the metal.

These light metals such as aluminum and magnesium are thus plated directly onto a substrate metal which may be an alloy metal such as steel, copper, iron, etc., whereby there is produced a composite product comprising the light metal integrally and tenaciously bonded to the metal or metal alloy which is of the heavy metal type.

Other metallic compounds which may be used to gas plate magnesium or aluminum as described are magnesium dimethyl; aluminum trimethyl; triarylmethylmagnesium halides; diphenylethynylmagnesium, aluminum hydride magnesium and aluminum nitrides and such as will decompose under temperature, pressure and inert atmosphere conditions imposed. The light metal halide compounds such as bromides, iodides or chlorides may be obtained from sea water or formed as by-products during the recovery or process of making various chemical compounds and products utilizing brine-containing waters.

Coatings of these light metals may be of various thickness as desired depending upon the use to which the article is to be put. A coating of 0.001 to 0.0025 inch is adequate for providing protection against corrosion in most instances.

The process makes possible continuous straight-line production of composite magnesium-aluminum products, such as wire, cable, metal plate, strip, sheet material or screen. The thickness of the coating may be controlled by limiting the duration of the gas plating or time the article remains in the plating enclosure. The invention is particularly useful in aluminizing metals where it is desirable that the metal be deposited penetrates the pores and interstices to form a substantially integral outer shell of aluminum metal.

The material being gas plated with the light metals may be composed of various metals or alloys and in the various shapes and forms described. To clean the metal preparatory to gas plating, use may be made of conventional methods, such as washing or immersing the material in alkali or acid solutions, and rinsing with clear hot water and heating to 150 to 200° C. for sufficient time to drive off all moisture and produce a perfectly dry surface. Electro-chemical cleaning methods as commonly used also may be employed if desired as well as mechanical cleaning methods, e. g. wire brushing and sandblasting.

Preheating and drying of the article prior to gas plating is preferably carried out in an inert atmosphere such as nitrogen, helium or the like to prevent oxidation. Thereafter the heated and completely dry metal surface is subjected to gas plating.

By employing gas plating in accordance with this invention, it is possible to envelop the material or article by a metal film or plate of any desired thickness, and which consists of substantially pure metal. A protective film is thus provided which film or plating does not have occluded foreign matter such as undesirable metals, salts, anode particles, bubbles and the like, which are inevitably plated out on the cathode along with the desired metal during ordinary electroplating methods in the absence of moisture or water vapor. Oxygen and oxidizable materials are also absent. The plating deposited by such gas plating method has been observed to produce a metal deposit which penetrates into the pores and interstices of the substrate metal but does not produce the undesirable brittle alloy effects as observed when such plating is applied by wet processes or molten metal plating methods. It is not known the exact reason for this, but it is believed that these beneficial effects are ac-

counted for by reason of the freedom of the metal deposit from impurities, particularly metal impurities which produce the brittle alloy characteristic property. The metal deposit at the interstices of the substratum by gas plating produces a tenacious intermediate portion which remains ductile and tough so that the metal thus plated can be worked as desired. Any desired thickness of plating may be deposited by gas plating, for example, so thin that the metal area is actually transparent and when deposited on a transparent substratum, such as glass, produces a smoked glass. The metal plating may also be increased so as to provide a coating thickness such as $\frac{1}{16}$ to $\frac{1}{32}$ " if desired, or greater.

In the use of conduit, pipe and the like conveying corrosive material, it is desirable to coat or plate the interior of the pipe so that it will resist corrosion. This may be done by gas plating so that the inner wall is resistant to corrosion. Metal plating done in this manner is very superior to wet plating methods because it has been difficult to bring about uniform plating on the interior of hollow objects, especially conduits. Furthermore, employing conventional wet electroplating methods there is always a certain amount, even though minor, of entrapment of electrolyte. While this may be imperceptible under ideal conditions, there is generally enough impurities plated out with the metal to ultimately cause deterioration of the plated article. Gas plating eliminates these difficulties because no electrolyte is present or required in order to carry out the process and as is a prerequisite element in performing the wet electrolytic plating process.

Further, gas plating makes it possible to bring nascent pure metal in direct contact with chemically clean substrate surfaces on which the metal is to be plated, and due to the deposition of the metal from a gaseous state, the penetration of the same deeply into the pores and interstices of the metal is accomplished without the inclusion of impurities and such as will alter the physical characteristics of the metal so that the interstitial plate portions function to actually enhance the physical characteristics of the base metal or substrate.

While the preferred procedure and a number of examples are given illustrating embodiments of the invention, and how the same could be carried out, it is to be clearly understood that this application is not to be restricted thereto, and that various changes and modifications as may occur to those skilled in the art may be made without departing from the spirit and scope of the invention, and as more particularly set forth in the appended claims.

What is claimed is:

1. A method of providing a metal body with an outer shell or layer of magnesium metal, which comprises the steps of cleaning the surface of said metal body, heating the resultant cleaned metal body in a dry, inert atmosphere and thereafter subjecting said heated body to an atmosphere comprising a heat-decomposable organometallic compound of said magnesium selected from the group consisting of the alkyl and aryl compounds of magnesium and maintaining the temperature sufficient to cause decomposition of the compound and deposition of the magnesium metal constituent onto the metal body and deeply into the pores and interstices of said metal body and without the inclusion of impurities.

2. A composite metal product made in accordance with the process of claim 1.

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