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ART OF COATING METALS

William J. Weder, Philadelphia, Pa., assignor to
General Electric Company, a corporation of
New York

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This invention relates broadly to the art of coating metals, and more specifically to the art of applying to metallic elements and alloys thereof that can be electroplated with mercury an electrolytically deposited coating of a metal that will amalgamate with mercury.

with pumice stone and water, then mercury dip, and finally to scrub the work again with a soft fiber brush in order to spread the mercury over the entire surface. The process was tedious, the results were non-uniform due in part to the personal element involved, and labor costs were relatively high.

This application is a continuation-in-part of my copending application Serial Number 139,207, filed April 27, 1937, which application, in turn, is a continuation-in-part of my copending application Serial Number 90,882, filed July 16, 1936, both of which applications are assigned to the same assignee as the present application, now being Patents 2,094,483 and 2,094,482, respectively.

It is an object of this invention to provide an improved method for coating metals and alloys thereof that can be amalgamated with mercury with a continuous, tightly adhering coating of another metal that can be electrolytically deposited upon a mercury surface and will amalgamate therewith.

In the art of coating metals that can be amalgamated with mercury, for example, copper, it has been known heretofore to coat the base metal with mercury either by rubbing it with metallic mercury or by chemically precipitating mercury from a mercury compound. Such methods have been described in the literature as a "quicking" treatment, but hereinafter will be referred to as a "mercury dip." It has also been known that other metals that can be electrolytically deposited and which will form an amalgam with mercury may be superposed on a metal previously coated with mercury in the manner just described. Metallic coatings produced in this manner have not been wholly satisfactory due to the difficulty experienced in obtaining a uniformly clean surface of the base metal prior to applying mercury thereto. By mercury dip methods the mercury coating was easily contaminated, for example with oxides of mercury, and such contamination materially lessened adhesion between the mercury layer and the layer or coating of metal subsequently electrolytically deposited upon the mercury surface. Further, in practical operations the base metal, particularly when using such a readily oxidizable metal as copper, tends to have a film of impurities, for example oxides, thereon. This film, even when present in a thickness undetected by the naked eye, hinders the formation of a complete bond between the mercury and the base metal. Coatings so produced result in considerable spoilage. For example, when silver has been electrolytically deposited on copper which previously has been coated with mercury in the manner before described, spoilage due to ineffective coatings often has been as much as 15%.

It is a further object of this invention to provide a method of the kind described in the preceding paragraph which method is economical, eliminates a large part of the personal equation in securing uniform results, and substantially decreases spoilage of the work.

In carrying this invention into effect I may proceed for example, as follows:

The metal article to be coated, for example, a portion of a copper element of an electrical device such as a copper electrical switch part at the point at which electrical contact is to be made, may be cleaned by dipping in a suitable acid solution such, for example, as a mixture of sulfuric and nitric acids or, under certain conditions, the copper part advantageously may be cleaned by first dipping it in a suitable alkaline solution, for instance a solution of caustic soda. After this it is water rinsed and dipped in an acid solution of the kind just mentioned. In either case, a final water rinse is given the article prior to further treatment.

The cleaned surfaces of copper or equivalent metal are then electroplated with mercury, using a suitable mercury-plating solution. For purpose of illustration I mention below a plating solution, specifically a mercury cyanide bath, which I have used successfully in mercury plating copper, although it is to be distinctly understood that other mercury-plating solutions may be employed and that the specified percentages may be varied as desired or as conditions may require:

Mercuric chloride.....	ounces.....	1½
Sodium cyanide.....	do.....	4
Ammonium chloride.....	do.....	2
Water.....	gallon.....	1

A solution made in the proportions stated is put into an electroplating tank of ferrous metal such as steel, which serves as the anode. The copper parts to be mercury plated are placed

In an effort to obviate the above-described difficulties it has heretofore been common practice to acid dip the work, followed by scrubbing

in this solution which is at room temperature. The copper articles form the cathode. Current is applied in well-known manner using, for example, a current density of from about 10 to 15 amperes per square foot. A uniform coating of metallic mercury is plated on the copper in from about 3 to 5 seconds. It is simply necessary to secure complete coverage, as any excess mercury merely falls off. If desired, surfaces not to be coated with another metal, and which therefore it would not be necessary to mercury plate in carrying the present invention into effect, may be masked to prevent plating thereof.

After electroplating of the mercury on the copper, the piece is rinsed in cold water and immediately thereafter is transferred to a plating bath of a metal capable of amalgamating with mercury, for example, a silver plating bath. For purpose of illustration I mention below a suitable silver-plating solution, specifically a silver cyanide bath, although here too it is to be distinctly understood that other silver-plating solutions may be employed and that the specified percentages may be varied as desired or as conditions may require:

Silver cyanide-----	ounces--	4
Sodium cyanide-----	do-----	6
Ammonium chloride-----	do-----	1/2
Water-----	gallon--	1

In this operation a conventional electroplating tank is employed. Silver bars immersed in the bath serve as the anodes and the mercury-plated copper articles as cathodes. Current is applied in well-known manner using, for example, a current density of from about 6 to 8 amperes per square foot. The work is allowed to remain in the bath until a silver coating of the desired thickness has been obtained. The bath is at room temperature during the entire plating operation. Using the described current density I have found that a 3 mil coating of silver will be deposited on the work in from about 2 to 2 1/2 hours. The plated article is removed from the bath, rinsed in hot water and then dried in any suitable manner, for example under an air blast.

Metallic coatings produced in accordance with this invention adhere very tenaciously to the base metal. For example, two copper articles each first electroplated with mercury and then silver plated when rubbed together under pressure showed no indication whatsoever of a peeling or separation of the silver coating from the copper; instead, the silver coating merely wore through to the copper base after prolonged rubbing together of the articles, and showed no signs of galling at any time.

The mercury plating operation, which is an essential step in practicing the present invention, provides a more uniform coverage of mercury on the work than otherwise may be obtained. In addition, the mercury apparently penetrates further within the surface of the work. It has been demonstrated under practical conditions of operation that an electrolytically applied coating or film of mercury on a metal surface better protects such surface from oxygen (air) than a mercury coating produced by a mercury dip. The presence of oxygen is objectionable in that directly or indirectly it is a cause of blister formation in the finished, coated article. The oxygen

apparently combines both with the base metal and with the mercury to form oxides thereof and results in poor adhesion of the mercury coating as a whole to the base metal.

The improved results obtained by practicing this invention are due in large part to the fact that oxides are eliminated both from the surface of the base metal and from the mercury coating thereon. This elimination of oxygen is accomplished when mercury is electroplated on the base metal, in contrast with the results of the mercury dip process, since the mercury is deposited simultaneously with the liberation of hydrogen which has a reducing effect on any oxides present. In this manner what properly may be described as a nascent action takes place, and, as a result, an improved bond or union between surfaces of the pure metals is obtained.

As more fully pointed out in my copending applications Serial Number 90,882 and 139,207, now being Patents 2,094,482 and 2,094,483, respectively, the amalgams formed between, for example, copper and mercury and between sheet silver and mercury are largely responsible for the strong bonds formed between such amalgamated metals under pressure or under heat and pressure. The formation of such amalgams has a similar beneficial effect in providing tenaciously adhering coatings that are produced in accordance with this invention.

In practicing my invention the coating metal, for example silver, is electrolytically deposited upon the mercury-plated base metal, for example copper, before any substantial oxidation of the mercury occurs. The mercury-plated metallic surface then may be said to be substantially oxide-free. By my invention the scrubbing operations commonly employed heretofore both before and after a mercury dip of the base metal are eliminated. Further, there is practically no spoilage whatsoever due to imperfect coatings.

Examples of metals which may be used in carrying this invention into effect are copper, silver, lead, tin, gold, cadmium, bismuth, antimony and alloys thereof. Such metals may serve either as the base metal or as the coating metal. A preferred embodiment of the invention consists in silver plating copper with the aid of an intermediate layer of electrolytically deposited mercury.

Of course it will be understood by those skilled in the art that an acid dip or a combination of an alkaline and acid dip results in a "brightening" of the metal surface.

The terms "metal" and "metals" as used hereinbefore include both substantially pure metal of the particular genus or species stated and alloys thereof.

What I claim as new and desire to secure by Letters Patent of the United States is:

The method of making an electrical contact point on a copper element of an electrical device which comprises cleaning at least that portion of the said element where electrical contact is to be made, electrolytically depositing a coating of mercury from a mercury cyanide bath upon the cleaned portion and electrolytically depositing a coating of silver from a silver cyanide bath upon the mercury coating.

WILLIAM J. WEDER.