UNITED STATES PATENT OFFICE.

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ELECTROPLATING.

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To all whom it may concern:

Be it known that I, AUGUSTUS ROSENBERG, a subject of the King of Great Britain, and a resident of London, W. C., England, have invented certain new and useful Improvements in Electroplating, of which the following is a full, clear, and exact specification.

This invention relates to the art of coating or plating electrically conductive surfaces with metals and to that particular method in which the article is coated by the frictional application of a powder to its surface. My invention differs, however, from such method inasmuch as it is based on the employment of a novel mixture of ingredients containing all that is necessary, when the mixture is brought into contact with water, to set up electrolytic action so that actual electro deposition of the metal is brought about by electrolytic action notwithstanding that no external source of current is employed. The process may be conveniently carried into effect by dipping a wet rag into the mixture so as to cause it to take up or become loaded with a sufficient quantity of the mixture and then rubbing the mixture adhering to the rag on to the surface of the article to be coated and repeating the operation as often as necessary to obtain the desired result.

One object of my invention is to provide a mixture whereby the electrolytic deposition may be carried out without the exercise of any skill, and in an efficient and economical manner, so as to permit the wide and convenient use of this powder for domestic or household purposes.

Another object of the invention is to provide a mixture by means of which a firmly adherent and substantial deposit may be produced in the manner described.

A further object of my invention is to provide a mixture of the kind referred to which may be kept indefinitely without losing its necessary qualities.

Other objects of my invention will be apparent from the following description and to these and the foregoing ends my invention consists in the particular combination of ingredients all in powdery form, for obtaining the deposition of metals and the use thereof as hereinafter specifically described and defined in the appended claims.

A further object of my invention consists in the employment, in combination with the metal to be deposited (which is employed in the chemically combined form), of a metal in its elementary state, electropositive with respect to the surface to be coated, and a substance which is capable of producing an aqueous electrolyte when brought into contact with water. In use, the substances in suspension or in solution in the electrolyte, as the case may be, set up electrolytic action which brings about the deposition of metal upon the surface to be coated. The electropositive metal may in some cases be the metal to be deposited itself, in which case the electrolyte is a salt of the same metal, or a salt capable of reducing said metal and of acting as an electrolyte when wetted.

Another important feature of my invention consists in the combination with the ingredients of inert substances (either of mineral or organic nature) which by their presence will prevent premature interaction of the ingredients which would otherwise take place or their chemical change previous to use.

A further feature of my invention consists in the use in the electroplating mixture of a substance or substances which acts (or act) either chemically or mechanically to impart a polish to the surface of the metal deposited.

As an example of a mixture prepared in accordance with my invention, I will give the formula of a mixture suitable for use in plating metals with nickel. This formula is as follows:

Nickel ammonium sulfate	60 parts
Magnesium	3 parts
Chalk	30 parts
Talc powder	7 parts
	100 parts

In this example the electropositive metal above referred to is the magnesium which is particularly adapted for the purpose as it is electropositive with respect to all of the common metals generally used for plating.

It is to be noted in general in every case

where the metal to be deposited is not, in itself, employed as the electropositive element hereinafter referred to, the metal which is so employed as electropositive element must not only be electropositive with respect to the metal to be deposited in combined form, but also to the surface to be plated.

The ammonium sulfate radical in the above formula constitutes, when moistened with water, the electrolyte. In this connection it may be noted that the use of an ammoniacal salt as an electrolyte is particularly recommended when the surface to be plated is greasy, as the alkaline solution of the ammonia gas liberated in the reaction dissolves the grease and thus facilitates the plating operation.

The talc powder in the above formula has the function of preventing the ammonium sulfate from acting upon the other ingredients in consequence of the absorption of moisture from the atmosphere, and the use of this or an equivalent substance is an important feature of the invention, since it permits the mixture to be stored or to be exposed to the atmosphere for lengthy periods without substantial deterioration.

The chalk of the formula acts as a diluent or filling and retards the action of the elements of the compound on each other, thereby affording the necessary time for the electrolytic action to occur in the best manner. The chalk is also useful, as it insures an alkaline reaction in the electrolyte. The chalk has a further mechanical function which will be referred to later. In the above-described operation the chalk, in addition to the functions specifically described, acts as a mechanical polishing agent, so that the frictional application of the mixture results: first, in the cleansing and polishing of the conductive surface; second, in the deposition of the nickel; and third, in polishing the newly deposited nickel.

In addition to the use of mechanical polishing agents, I may make use of agents having a chemical effect resulting in a polished surface on the deposited metal. For this purpose I have found carbohydrates, such as sugar, dextrin, and gum, to be effective when employed in a mixture in which the electrolyte is a sulfate or a double salt containing the radical SO_4, the latter probably forming with the carbon of the carbohydrates, carbon disulfid, a substance which is well known to have a polishing or brightening effect upon the electrically deposited metal.

The friction employed in applying my electroplating mixture is useful in several ways. It acts, first, to assist the cleaning of the surface to be plated. It assists the chemical and electrical actions by bringing the elements of the mixture in close contact and by mechanically depolarizing the metallic elements of the electric couples by which the electric current is generated. Finally it acts, as before pointed out, to polish the deposited metal.

While the talc powder acts as above pointed out to prevent the absorption of moisture from the atmosphere and thus to prevent premature chemical action between the ingredients of the mixture, I find it useful, particularly where a strongly electropositive metal, such as magnesium, is employed, to prevent oxidation and protect such metal absolutely from contact with the corrosive electrolytic salt, and to this end I have devised the expedient of coating the particles of the electropositive metal with an inert substance preferably of waterproof character, for which purpose I find organic substances, such as waxes and resins, to be suitable. The most convenient way in which to coat the particles is to moisten them with a solution of wax or resin in gasolene or other volatile solvent, and then dry out the solvent, after which the coated metal is mixed with the other ingredients of the mixture. When the mixture is used the friction employed in the application quickly causes the removal of the coating material and the exposure of the metal to the electrolyte. The coating of the electropositive metal has the further advantage that it prevents chemical action upon the electropositive metal upon the first wetting of the mixture, and this affords opportunity for the salt of the metal in solution to be deposited.

In addition to the ingredients hereinbefore mentioned, it may sometimes be desirable to add certain acid substances, such as boracic acid, or alkalies, such as sodium carbonate, in order to give the composition either an acid reaction or an alkaline reaction, as may be desirable under circumstances well known to those skilled in the art of electroplating.

My invention is applicable for depositing almost any metal upon itself, for example, zinc upon zinc, or upon any other metal generally used in the art of electroplating, and it will be understood that the several ingredients hereinabove referred to may be used in proportions widely varying from those given in the preceding formula, and that the use of some of them is optional and is governed by the widely varying purposes for which my invention may be used.

In the application of the mixture in the manner described, the electropositive metal constitutes the anode and the object to be coated the cathode and both being in suspension in the electrolyte, current is gen-

erated. Owing to the comminuted state of the electropositive metal, innumerable small contacts with the cathode surface are made and the particles of electropositive metal act as so many minute anodes, each setting up local circulations of electric current. The circuits are so excessively small, so exceedingly near together and so numerous that they cannot be separately observed, but each causes a deposit of the metal to be deposited upon the cathode surface. Owing to the number of small currents generated, these, as they leave the liquid, deposit a film of the metal to be deposited over the surface to be coated.

The foregoing description of the manner of carrying out my invention is for the purpose of illustration only and is not intended to be exclusive. It is also obvious that many modifications and changes may be made in my invention without departing from the spirit of the same, and I do not desire to limit myself to the particular features described, but

What I claim and desire to secure by Letters Patent is:

1. The method of electroplating which consists in the frictional application to an electrically-conductive surface, in the presence of an electrolyte containing in solution the metal to be deposited, of a second metal electropositive with respect to both said surface and said metal in solution, said electropositive metal being in elemental and comminuted form.

2. The method of electroplating which consists in the frictional application to an electrically-conductive surface, in the presence of an electrolyte containing a double salt of the metal to be deposited, of a metal electropositive with respect to said surface and in elemental and comminuted form.

3. The method of electroplating which consists in the application to an electrically-conductive surface, in the presence of an electrolyte, of a salt of the metal to be deposited, together with a polishing agent.

4. The method of electroplating which consists in the frictional application, to an electrically-conductive surface, in the presence of an electrolyte, of a salt of the metal to be deposited, together with a mechanical polishing agent.

5. The method of electroplating which consists in the application, to an electrically-conductive surface, in the presence of a solid diluent and of an electrolyte containing in solution the metal to be deposited, of a second metal electropositive with respect to both said surface and the metal in solution, said electropositive metal being in elemental and comminuted form.

6. The method of electroplating which consists in the application, to an electrically-conductive surface, of a mixture comprising comminuted, elemental magnesium, and of an electrolyte having in solution the metal to be deposited.

7. The method of electroplating which consists in the frictional application, to an electrically-conductive surface, in the presence of an electrolyte holding in solution the metal to be deposited, of comminuted elemental magnesium.

8. The method of electroplating which consists in the application to an electrically-conductive surface in the presence of a solid diluent, and of an electrolyte containing in solution a salt of the metal to be deposited, of a second metal electropositive with respect both to said surface and to the salt of the metal in solution, said electropositive metal being in elemental and comminuted form.

9. The method of electroplating which consists in the application to an electrically-conductive surface of a mixture comprising comminuted elemental magnesium and an electrolyte having in solution a salt of the metal to be deposited.

10. The method of electroplating which consists in the frictional application to an electrically-conductive surface in the presence of an electrolyte containing in solution a salt of the metal to be deposited, of comminuted elemental magnesium.

11. The method of electroplating which consists in making a dry mixture comprising a salt of the metal to be deposited and a second metal in elemental and comminuted form, moistening said mixture and applying it to an electrically-conductive surface.

12. The method of electroplating which consists in making a dry mixture comprising a salt of the metal to be deposited, and a second metal in elemental and comminuted form, moistening said mixture and applying it frictionally to an electrically-conductive surface.

13. The method of electroplating which consists in making a dry mixture comprising comminuted, elemental magnesium and a salt of the metal to be deposited, moistening said mixture and applying it frictionally to an electrically-conductive surface.

14. The method of manufacturing an electroplating mixture which consists in coating metal particles with an inert substance and mixing the coated particles with a salt soluble in water.

15. The method of manufacturing an electroplating mixture, which consists in coating metal particles with a waterproofing substance and mixing the coated particles with a salt soluble in water.

16. The method of manufacturing an electroplating mixture which consists in coating metal particles with a solution of

protective material, drying said particles, and mixing them with a salt soluble in water.

17. A mixture for use in electroplating, consisting in metal particles coated with protective material.

18. A mixture for use in electroplating, consisting in metal particles coated with waterproofing material.

19. A mixture for use in electroplating, consisting in metal particles coated with organic matter.

20. A mixture for use in electroplating, consisting in metal particles coated with wax.

21. A mixture for use in electroplating, consisting in particles of magnesium coated with protective material.

22. A mixture for use in electroplating, consisting in particles of magnesium coated with organic matter.

23. A mixture for use in electroplating, comprising comminuted metal and a pulverulent salt capable of constituting an electrolyte when moistened.

24. A mixture for use in electroplating, comprising a comminuted metal and a pulverulent salt of the metal to be deposited.

25. A mixture for use in electroplating, comprising comminuted magnesium and a salt of the metal to be deposited.

26. A mixture for use in electroplating, comprising a comminuted metal, a pulverulent salt capable of constituting an electrolyte when moistened, and a pulverulent inert material.

27. A mixture for use in electroplating, comprising a comminuted metal, a salt soluble in water, and a pulverulent carbohydrate.

28. A mixture for use in electroplating, comprising a comminuted metal, a salt soluble in water, and a pulverulent material insoluble in water.

29. A mixture for use in electroplating, comprising comminuted magnesium, a salt of the metal to be deposited, and a pulverulent material insoluble in water.

30. A mixture for use in electroplating, comprising a comminuted metal, a salt soluble in water, and pulverized talc.

31. A mixture for use in electroplating, comprising comminuted magnesium, a salt of the metal to be deposited, a pulverulent material insoluble in water, and a pulverulent carbohydrate.

32. A mixture for use in electroplating, comprising metal particles coated with protective material, and a salt capable of constituting an electrolyte when moistened.

33. A mixture for use in electroplating, comprising metal particles coated with protective material, a salt of the metal to be deposited, and a pulverulent polishing material.

34. A mixture for use in electroplating, comprising metal particles coated with waterproofing material, and a pulverulent salt soluble in water.

35. A mixture for use in electroplating, comprising particles of magnesium coated with protective material, and a salt of the metal to be deposited.

36. A mixture for use in electroplating, comprising particles of metal coated with protective material, and a salt of a metal electronegative with respect to the metal of said particles.

37. A mixture for use in electroplating, comprising a carbohydrate and a sulfate of the metal to be deposited.

38. A mixture for use in electroplating, comprising a carbohydrate, the sulfate of the metal to be deposited, and a metal electropositive with respect to the metal to be deposited, and in elemental and comminuted form.

39. The method of electroplating which consists in the frictional application to a conductive surface in the presence of moisture, of a mixture of pulverulent materials including a salt of the metal to be deposited, an electropositive metal and a substance capable of yielding, in conjunction with moisture, an aqueous electrolyte.

40. A method of electroplating which consists in the frictional application to said surface in the presence of moisture, of a mixture containing pulverulent materials, including a salt of the metal to be deposited, an electropositive metal present in the elementary state, and a substance capable of yielding, in conjunction with moisture, and an aqueous electrolyte.

41. As a new article of manufacture for depositing a metal upon a conductive surface, a mixture of pulverulent materials including a salt of the metal to be deposited, an electropositive metal, and a substance capable of yielding, in conjunction with moisture, an aqueous electrolyte.

42. As a new article of manufacture for depositing a metal on a conductive surface, a mixture of pulverulent materials including a salt of the metal to be deposited in its elementary form, an electropositive metal, and a substance capable of yielding, in conjunction with moisture, an aqueous electrolyte.

43. As a new article of manufacture for depositing a metal upon a conductive surface, a mixture of pulverulent materials including a salt of the metal to be deposited, an electropositive metal, and a salt.

44. As a new article of manufacture for depositing a metal upon a conductive surface, a mixture of pulverulent materials including a salt of the metal to be deposited, an electropositive metal, a salt, and a substance capable of preventing the absorption of moisture.

45. As a new article of manufacture for depositing a metal upon a conductive surface, a mixture of pulverulent material including a salt of the metal to be deposited, an electropositive metal, and a soluble salt.

46. As a new article of manufacture for depositing a metal upon a conductive surface, a mixture of pulverulent material including a salt of the metal to be deposited, an electropositive metal, a soluble salt, and a substance capable of preventing the absorption of moisture by the said salt.

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Witnesses:
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WILLIAM G. E. DAVIES.