Patented May 5, 1925. 1,537,053

UNITED STATES PATENT OFFICE.

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PROCESS OF COLORING CADMIUM.

No Drawing. Application filed April 2, 1924. Serial No. 703,781.

To all whom it may concern:

Be it known that I, ARTHUR WHITE YOUNG, a citizen of the United States, residing at Kokomo, in the county of Howard and State of Indiana, have invented certain new and useful Improvements in Processes of Coloring Cadmium, of which the following is a specification.

The coating of metals and metal articles with cadmium, see United States patents to Udy and Nicholson Nos. 1,383,174, 1,383,175 and 1,383,176 and an application Ser. No. 459,983 filed April 9, 1921, in the names of Wissler and Humphries and now in issue, has given rise to a demand for a suitable method of coloring cadmium surfaces.

After extensive experimentation I have devised a satisfactory method for producing very adherent and permanent colorings in a variety of shades upon cadmium which consists generally in subjecting the article to be colored to the action of an ammoniacal solution of ammonium molybdate. I am aware of the proposed use of ammonium molybdate for coloring metals described in Hiorns "Metal Coloring" published by MacMillan & Co. in 1902, pages 235 and 236, but so far as I am aware the proposed process has never reached the state of successful commercial application, nor has the process been proposed or applied for the coloring of cadmium.

I am also aware of a United States patent to Roux No. 1,095,357, in which is described a method of coloring metals by the use of ammonium molybdate but this process apparently has not come into commercial use and has not been proposed so far as I am aware for the coloring of cadmium.

Heretofore the commercial coloring of metals has been more or less empirical generally involving the use of a specific and more or less complicated combination of chemicals, and in some cases a special rule-of-thumb procedure for the production of each particular desired color upon each particular metal.

Now, in accordance with my invention, the procedure for the coloring of cadmium is simple and well understood and a variety of colors may be produced from the same simple mixture of chemicals in a regular and controllable manner.

The process of coloring cadmium in accordance with my invention consists generally in contacting the cadmium or cadmium coated article to be colored with a solution of ammonium molybdate containing free ammonia.

All sorts of articles may be colored by the process of my invention including for instance articles of regular and irregular shapes which may be made of pure cadmium or cadmium alloy or of other materials coated with cadmium either electrolytically or otherwise. The process is particularly designed and adapted for the coloring of a very thin electrodeposit or coating of cadmium such as described in the patents and application referred to above.

The coloring may be accomplished by simply immersing the articles to be colored in an ammoniacal ammonium molybdate solution or an electric current may be applied for the purpose of hastening the coloring operation. All of the features of the process in which electric current is employed to be described in detail hereinafter are applicable in the same way and with the same effect to the process in which electric current is not employed, the only essential difference between the two procedures being that the coloring with the use of electric current, other conditions being the same, is much more rapid than the coloring without the use of electric current.

A preferred procedure in accordance with my invention is to make the article or articles to be colored the cathode in an electrical circuit including the ammoniacal ammonium molybdate bath and a suitable inert anode which may conveniently be the steel or other suitable metal receptacle for the bath. The rate of coloring varies with the temperature of the bath, the ammonium molybdate concentration of the bath and the current density upon the article to be coated. That is, the rate of coloring increases with the temperature and concentration of the bath and with increase of current density. But since neither a particular temperature, a particular concentration or a particular current density is essential to the coloring all three of these factors may vary within a wide range. Successful coloring has been accomplished with baths varying from the equivalent of 1 ounce of molybdic acid per gallon up to the saturation point, 8 ounces per gallon being a suitable figure for commercial operation. Temperatures as high

as 180° F. have been employed although in most cases a somewhat lower temperature, say in the neighborhood of 100° F. to 120° F. is preferred. Current densities of from 1 to 10 amperes per square foot constitute a suitable operating range.

The rate of coloring to be used in any particular case will depend to some extent upon the particular color desired. The coloring begins immediately when the cadmium or cadmium coating is brought into contact with the ammoniacal ammonium molybdate bath and progresses through the following colors in the order named: light yellow, steel gray, light yellow, gold, red, purple, green, red, and then alternating between green, red and brown until a final black color is produced. In between the mentioned main colors there are of course a variety of intermediate color combinations. Now if the final black color is to be produced it is of course advisable to employ the most rapid coloring conditions, but if an intermediate color is desired the rate of coloring must be sufficiently slow to permit the withdrawal of the article being colored from the bath at the proper time. If the coloring is very rapid it is of course very difficult to stop it at a precise point.

The time required for the coloring operation is illustrated by the following examples. With a bath containing about the equivalent of 2 ounces of molybdic acid per gallon at room temperature and without the use of electric current the final black color is produced in about 2 hours. If this bath is heated to say 100° F. the final black color is produced in about 1 hour. If the concentration of the bath is increased to about the equivalent of 8 ounces of molybdic acid per gallon and heated to about 100° F. and electric current is employed the final black color may be produced in as short a time as 5 minutes. The intermediate colors of course require a shorter time and the change from to color to color is fairly rapid.

Particularly desirable polychrome color effects containing practically all of the colors of the rainbow may be produced by varying the time of the action of the bath upon different parts of the articles, for instance by slowly immersing or withdrawing the article from the bath in a continuous or step by step movement. Very beautiful finishes particularly applicable for art work may be produced in this way.

The bath may be maintained and operated continuously for a long period of time by replacing its losses by suitable additions of ammonia, ammonium molybdate and water.

The colors are permanent and not evanescent upon exposure to the atmosphere and to light, and the color film is very adherent being difficult to remove even with a buffing wheel. In order to protect the colored surfaces against being scratched they may be coated with a clear lacquer.

Soluble molybdates other than the ammonium molybdate, for instance sodium and potassium molybdate may be employed, but the ammonium molybdate is preferred.

I have also found in the course of my investigations that other salts may be used for coloring cadmium, such as chromates which give a green color which, however, is not adherent. Ammonium tungstate may be made to give the same range of colors as ammonium molybdate but only under difficult conditions, using very high current densities and highly concentrated solutions.

In conclusion it is noted that my invention provides a rapid and cheap method which is easily carried out for the production of a great variety of colors and shades of color and color effects upon rust proof cadmium coated articles, said colors being permanent and strongly adherent.

I claim:

1. Process of coloring cadmium and cadmium coated articles which comprises contacting an article to be colored with an ammoniacal solution of ammonium molybdate maintained at a temperature of from 100° F. to 180° F. in an electrical circuit in which said article serves as the cathode.

2. Process of coloring cadmium and cadmium coated articles which comprises contacting an article to be colored with an electrolytic bath containing free ammonia and ammonium molybdate in quantity equivalent to about 8 ounces of molybdate acid per gallon of the bath, maintaining said bath at an elevated temperature and passing an electric current through the bath in a circuit in which said article to be colored serves as the cathode.

3. Process of coloring cadmium and cadmium coated articles which comprises contacting an article to be colored with an ammoniacal solution of ammonium molybdate maintained at a temperature of from 100° F. to 180° F.

In testimony whereof, I affix my signature.

ARTHUR WHITE YOUNG.