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PROCESS OF PRODUCING CORROSION-RESISTING COATINGS ON IRON AND STEEL AND PRODUCT.

No Drawing. Application filed February 25, 1926. Serial No. 90,690.

I have found that by applying a very thin coating of chromium over coatings of other metals upon iron and steel, products having very desirable corrosion resisting properties may be produced, and further that the chromium coating can be produced in such form that further mechanical finishing thereof is unnecessary.

In Patent No. 1,545,196, to Harrie C. Pierce and Chad H. Humphries, there is described a method of producing extremely thin, continuous and coherent coatings of chromium upon other metals. Such chromium coatings have excellent corrosion preventing properties. Under certain circumstances, however, it is unwise to trust solely to the chromium coating. The present invention therefore relates to the application of multiple coatings of certain metals, the outermost of which is chromium, and to the products so produced.

In producing these coatings the patented method is advantageously, (although not necessarily) used. In another and copending application, No. 718,080, filed June 5, 1924, I have described and claimed compound platings of this nature.

The invention embraces quite a variety of combinations of coatings among which may be mentioned by way of example the following:

Chromium on copper on iron or steel;
Chromium on brass on iron or steel;
Chromium on copper on cadmium on iron or steel;
Chromium on copper on zinc on iron or steel;
Chromium on brass on cadmium on iron or steel;
Chromium on brass on zinc on iron or steel;
Chromium on cadmium on iron or steel;
Chromium on zinc on iron or steel;
Chromium on nickel on iron or steel.

The coatings may be applied by any suitable electroplating method but with regard to the chromium coating it is desirable from a commercial standpoint that a process be used which will give a lustrous coating at low current density, otherwise, for instance, if a high current density is required or if the coating is not lustrous, some of the value of the composite coating from a commercial standpoint is lost. I, therefore, find it advantageous to use the process of chromium plating which forms the subject matter of the Pierce and Humphries patent above referred to. Said process consists generally in electrodepositing chromium at a relatively low current density, say from 14 to 125 amperes per square foot, but preferably in the neighborhood of 14 to 40 amperes per square foot, from a bath containing essentially chromic acid, ammonium sulfate and hydrated chromic hydroxide dissolved in water at room or slightly elevated temperature, using either inert or soluble anodes.

The bath may be prepared by mixing a solution of chromic acid in water with a solution of the reaction products of chromic sulfate and ammonium hydroxide in water. The quantity of chromic acid used may vary from 80 to 450 grams per liter of the final solution. The chromic sulfate is used in quantity amounting to .5 to 2 per cent of the chromic acid and the ammonium hydroxide preferably in quantity about chemically equivalent to the chromium sulfate. The invention is not limited to the use of the particular bath and process for applying the chromium coating described above. The so-called "Sargent's" solution for which somewhat higher current densities are recommended may be used.

The following examples illustrate the process:

(1) Iron or steel articles, properly prepared mechanically for finish and by ordinary plating room cleaning methods to receive an electrodeposited coating, are plated in a zinc cyanide bath with a coating of zinc approximately .0001 inch or more in thickness, rinsed in water and given an electrodeposited coating of copper or brass from a copper cyanide or standard brass plating bath, subjected to mechanical buffing or to a bright acid dip to give the copper or brass

coating a high luster, and then coated with chromium by means of the Pierce and Humphries chromium plating process described above.

(2) Iron or steel articles properly prepared for electroplating and finishing as described in Example 1 are plated with copper in a cyanide copper plating bath alone or in a cyanide copper bath and then in an acid copper bath to produce the desired thickness of the copper coating and then plated with chromium as described.

The multiple coatings with a chromium coating on the outer surface produced in accordance with this invention give remarkable atmospheric corrosion and acid fume resisting properties to the coated articles. A coating of chromium on copper on zinc on steel with the zinc coating .0001 inch thick and the copper coating .0001 inch or less thick and the chromium coating .00006 inch or less thick by computation, after being subject to the standard salt spray test for 80 hours showed no evidence of rust streaks or areas, or pin holes, and the original bright luster of the chromium coating was undimmed. For comparison it is noted that standard nickel on steel and nickel on copper on steel platings subjected to the same salt spray test failed in 10 hours, while a nickel on cadmium on steel coating failed in 24 hours. The chromium coated articles not only withstand corrosion longer than the other standard coatings referred to, but have the additional and very important further advantage that they retain their luster and do not become dulled or tarnished.

The chromium coatings should not be of less than a computed thickness of .00006 inch, because with coatings of less than this thickness there is a tendency for the under coatings to show through after standing, there being evidence of chromium absorption.

Of the composite coatings those in which the chromium over-coating is deposited directly upon an under-coating of copper or brass are advantageous for some purposes because chromium coatings upon copper and brass show a greater tendency to be lustrous and the production of a lustrous finish directly obviates the more or less expensive mechanical coloring treatment which otherwise would be necessary in order to produce lustrous finishes. On the other hand, in some relations the use of a relatively more electropositive metal than copper next the chromium outer coat is more advantageous. With chromium on zinc or cadmium on steel, there are two electropositive metals over the electronegative steel, the outermost metal (chromium) being not only extremely hard and resistant to abrasion but also usually of remarkable continuity and freedom from pinholes. When a copper or brass coating is deposited directly upon the iron or steel to serve as a carrier for chromium it should be made somewhat heavier than when the under-coating of cadmium or zinc is used for carrying the chromium.

The corrosion resisting properties of the composite coatings of the present invention may be explained in part by the fact that the chromium coatings are very hard and protect the under-coating against abrasion. A further explanation is as follows:

When iron is protected against corrosion by coatings of metal such as cadmium and zinc which are electropositive to iron the protection is given by the preferential oxidation of the coating metal while when coatings of nickel alone or nickel on copper on iron are used, the protective action is due solely to the continuity of the coatings since both copper and nickel are electronegative to iron. In the case of coatings of nickel on cadmium or zinc on iron the intermediate metal, cadmium or zinc which is electropositive to both the iron and nickel, is very rapidly used up due to electrolytic action in case pinholes or breaks in either the iron or nickel occur. Such conditions do not exist in the coatings of the present invention. For instance, in the case of the coatings of chromium on copper on cadmium on iron the relationship is as follows. Cadmium is positive to iron, copper is negative to the cadmium and the chromium is electropositive to both the copper with which it is in contact and also to the iron. In the case of chromium on copper or iron, the more electropositive metal is on the outside and not as in the case of nickel on cadmium on iron, sandwiched between two electronegative metals. In the case of chromium on zinc on iron both of the coating metals are electropositive to the iron.

Cadmium offers a number of advantages as an intermediate metal between iron and chromium. It is electropositive to iron and affords a particularly good type of coating. It may be applied to an iron or steel article by any of the usual methods and the cadmium plated article then chrome plated by the Pierce and Humphries method mentioned above or another method.

This application contains matter derived from the acknowledged application Serial No. 718,080, filed June 5, 1924.

What I claim is:—

1. The process of protecting iron and steel articles against corrosion which comprises electrodepositing upon the surface of such an article composite coatings comprising a layer of a metal electropositive to iron and a superposed layer of chromium.

2. Process for the protection of iron and steel articles against corrosion which com-

prises electrodepositing on the surfaces a layer of cadmium and a superposed layer of chromium.

3. As an article of manufacture a piece of iron or steel having a coating comprising a layer of a metal electropositive to iron and a superposed layer of chromium.

4. As an article of manufacture a piece of iron or steel having a coating comprising a layer of cadmium and a superposed layer of chromium.

In testimony whereof I have hereunto set my name at Indianapolis, Indiana, this 23rd day of February, 1926.

CHAD H. HUMPHRIES.