UNITED STATES PATENT OFFICE.

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COATING WITH METAL.

1,014,749. Specification of Letters Patent. Patented Jan. 16, 1912.

No Drawing. Application filed April 2, 1910. Serial No. 552,940.

To all whom it may concern:

Be it known that I, CHARLES F. BURGESS, a citizen of the United States, residing at Madison, county of Dane, State of Wisconsin, have invented certain new and useful Improvements in Coating with Metal, of which the following is a specification.

The present invention relates to the art of covering metal or metallic objects with a protective or ornamental coating by making use of a brittle alloy in granular condition wherein the article or object to be coated may be heated to receive its covering.

More particularly, it relates to the art of coating iron or steel with a homogeneous and uniform covering, electro-positive with respect to the iron or steel, and in many respects different from the zinc coating commonly used.

My invention also embraces the product thereby produced.

It is common practice in the art of coating metals to dip an iron object or article, after suitable cleaning, into a bath of fused zinc, thereby producing on the surface of the iron a covering capable of protecting it from corrosion. This process has some disadvantages or limitations, such, for example, as the danger that the high temperature may injure the iron or steel article during the coating operation, as by drawing the temper, and the difficulty of controlling the thickness and crystalline structure of the coating produced. Furthermore, the process is expensive, not only because of the initial cost of the installation and of the fused bath of pure zinc, but also because of deterioration of the zinc bath. It has been found that the molten zinc alloys with iron or steel objects dipped therein, and also alloys with the iron tank or receptacle in which the molten zinc is ordinarily held. The alloy so formed is commonly known as "dross," and sinks to the bottom of the tank, from whence it must be removed from time to time. This alloy analyzes about 97% zinc, and 3% iron, and is sold at a comparatively low price as a by-product of the hot galvanizing process.

According to the present invention, the metal to be coated, say an iron or steel article, is suitably cleaned, as by sand blasting and pickling, or the like, and then is brought into contact with a zinc alloy, and heated until it takes on a protective coating or covering. The zinc alloy preferable for this purpose has a composition of about $FeZn_{10}$, and can be made by adding to molten zinc, clean iron, say wrought iron, in small pieces, until the zinc dissolves or takes up the necessary amount of iron. In a certain sense, the alloy may be regarded as a saturated solution of iron in zinc. In making up this alloy, it is not necessary to start with pure iron and pure zinc, but, on the contrary, it is possible to start with the zinc-iron alloy or "dross" above referred to as the by-product of hot galvanizing, adding sufficient iron to the fused alloy to bring the proportions up to about the relation $FeZn_{10}$. When made from dross as a basis, the $FeZn_{10}$ alloy is relatively cheap.

After cooling, this zinc alloy, $FeZn_{10}$, is very brittle, and can be crushed without difficulty, and ground into a granular condition. This brittleness is attributable to the presence of the $FeZn_{10}$ compound in such quanity that its tendency to crumble or break up will preponderate over the strengthening action of a residual uncombined zinc. With the alloy or compound $FeZn_{10}$ the brittleness seems to be due to the extremely crystalline character of the material and to the pronounced development of cleavage planes and areas of mechanical weakness, this being so pronounced that the material produced as above described is so brittle that very often it may be crumbled into granular condition merely by pressure of the fingers. It need not be ground fine.

To coat a metal article, the zinc-iron alloy in granular form is applied to the surface of the article, and is there submitted to the action of heat until an adherent coating results. This operation may be effected by placing the article in a closed drum or receptacle, together with a quantity of the granular $FeZn_{10}$, and then heating to a moderate temperature. The air need not be totally excluded from the drum during this heating operation. The drum can be rotated to maintain intimate contact between the granular alloy and the iron article, and the temperature and duration of heating can be suitably regulated to govern the thickness of the coating. Heating for two hours and to a maximum temperature of about dull red, (700 to 800 deg. F.), gives good results. This temperature is well below the

temperature at which the granular material becomes sticky or inclined to sinter into a firm mass. No oxid of zinc need be present, though its presence does not appear to interfere seriously with the normal operation of the process. Carbon may be present, as from carbonization of oil carried by articles not thoroughly cleaned, but its presence is neither necessary nor essential. The granular $FeZn_{10}$ is easy to work, is not injurious to workmen, does not oxidize readily and will not explode.

The coating produced as herein described, appears, to the naked eye, as a very dense silver-like coating, with a mat-like surface, and is altogether different from the crystalline deposit produced by hot galvanizing. I have ascertained that this protective layer is substantially uniform in composition throughout the greater part of its thickness, and that it has a chemical composition of about $FeZn_{10}$. It is somewhat hard and dense in structure, harder than pure zinc, and has a single-potential or electrochemical contact potential of about 0.23 as compared with zinc 0.56. I mean by this that there is a potential of 0.23 volts between the coating and a normal zinc solution, as measured against a standard calomel electrode, assuming for the calomel electrode the usual value of 0.56. It is therefore electro-positive with respect to iron, but only slightly so, and as a consequence, it protects the iron from corrosion without itself being subject to rapid wasting away through electrolytic action.

Although the present description has been directed more particularly to an embodiment wherein a rotary drum is used, it will be understood that when the iron or steel articles are not suited for treatment in a drum, either because of large size or unwieldly character, then various other expedients, well known to those skilled in the art, may be resorted to for insuring intimate contact between the granular material and the iron during the heat treatment.

Although the preferred embodiment of the method herein described makes use of a granular material wherein substantially all the zinc is chemically combined with the iron as $FeZn_{10}$, I have found that this relation of the constituent metals is not imperative, and that good coatings can be obtained when some considerable excess of zinc is present. Such a material containing free zinc, when examined under the microscope shows crystals of $FeZn_{10}$ mixed with zinc, but chemically uncombined therewith, and has a melting or sintering temperature lower than that of pure $FeZn_{10}$, the exact temperature depending on the quantity of excess zinc present.

In an application Serial No. 567,244, filed by me June 16, 1910, claims are made on a process of coating an iron surface by suitable heat treatment with a granular material which has been enriched with additional zinc. In an application Serial No. 595,205, filed by me December 2, 1910, claims are made on the granular material itself and on the method by which it is produced.

The alloy $FeZn_{10}$ fuses at about 1300 degrees Fahr., and this is well above the temperatures at which the coating operation would ordinarily be effected, even though the temperature had been raised to a high value for the purpose of increasing the speed of deposition. But the melting point of pure zinc is only about 740 degrees Fahr., and this is so low that zinc alone is unsuited for use as the granular material of the coating process. Consequently, if the granular material of the process does consist of zinc associated with the crystals of $FeZn_{10}$, the quantity of zinc present must be small enough not to lower the fusing or sintering temperature of the mass below the temperature at which the coating operation is to be effected and the quantity of $FeZn_{10}$ present must be sufficient to give to the entire granular mass the characteristic brittleness and resistance to sintering at the temperature at which an iron article will take on a protective covering of the alloy.

In the appended claims, the term iron is used as generic to the various kinds of metals in which iron is the sole or the major constituent.

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

1. The process of coating a metal surface which consists in applying thereto a brittle alloy in granular condition and composed mainly of zinc, and submitting the same to heat.

2. The process of coating an iron surface, which consists in applying thereto a brittle alloy in solid condition and composed mainly of zinc, and submitting the same to the action of heat.

3. The process of coating an iron surface which consists in applying thereto a brittle alloy of zinc and iron in subdivided condition, and submitting the same to the action of heat.

4. The process of depositing a protective coating on an iron article which consists in applying to the article an alloy of zinc and iron in granular condition, and submitting the same to the action of heat.

5. The process of depositing a protective coating on an iron article which consists in applying to the article a granular zinc-iron alloy of about the composition $FeZn_{10}$, and submitting the same to the action of heat.

6. The process of coating iron articles, which consists in heating said articles to about dull red while in contact with a gran-

ular zinc-iron alloy of about the composition $FeZn_{10}$.

7. The process of coating an iron article with a protective layer, which consists in heating the article at about dull red while in contact with $FeZn_{10}$.

8. The process of coating a metal article with a protective layer of zinc-iron alloy which consists in heating the article to about dull red, while in contact with a zinc-iron alloy in granular condition.

9. The process which consists in forming an alloy of zinc and iron of about the composition $FeZn_{10}$, reducing said alloy to granular condition, applying said granular material to an iron surface, and submitting the same to the action of heat to produce a uniform adherent coating.

10. The process of coating an iron article with a protective covering containing zinc, which consists in adding iron to zinc-dross to form an alloy which is brittle, applying said brittle alloy in subdivided condition to the article to be coated, and submitting the same to heat.

11. The process of coating an article with a protective covering containing zinc and iron, which consists in adding metal to zinc-dross to form a material which is brittle, applying said brittle material in subdivided condition to the article to be coated, and submitting the same to heat.

12. The product produced as herein described and comprising an iron article having an electropositive coating which throughout is of about the composition $FeZn_{10}$, said coating having a soft, silver color to the naked eye, and a single-potential of about 0.23 volts.

13. As a new product, a metallic object produced as herein described, and having a surface coating of zinc-iron alloy of about the composition $FeZn_{10}$, this coating being characterized by a silver color, freedom from crystalline structure when examined by the naked eye, a single potential lower than that of pure zinc, and a hardness somewhat greater than that of pure zinc.

14. As a new product, an iron article coated as herein described with a homogeneous adherent covering consisting mainly of zinc, said covering having at its exposed surface a single potential less than that of zinc and having a freedom from crystalline structure when examined by the naked eye.

15. The process of coating a metal article which consists in applying thereto a brittle alloy in granular condition, said alloy containing zinc and iron, and submitting the same to the action of heat.

16. The process of coating a metal which forms with zinc a brittle alloy reducible to granular condition, said process consisting in applying to said metal said granular alloy, and submitting the same to the action of heat until the metal takes on a covering of said alloy.

In witness whereof, I have hereunto set my hand this 29th day of March, A. D. 1910.

CHARLES F. BURGESS.

Witnesses:

VROMAN MASON,

IRMA WISWALL.