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COATING PROCESS

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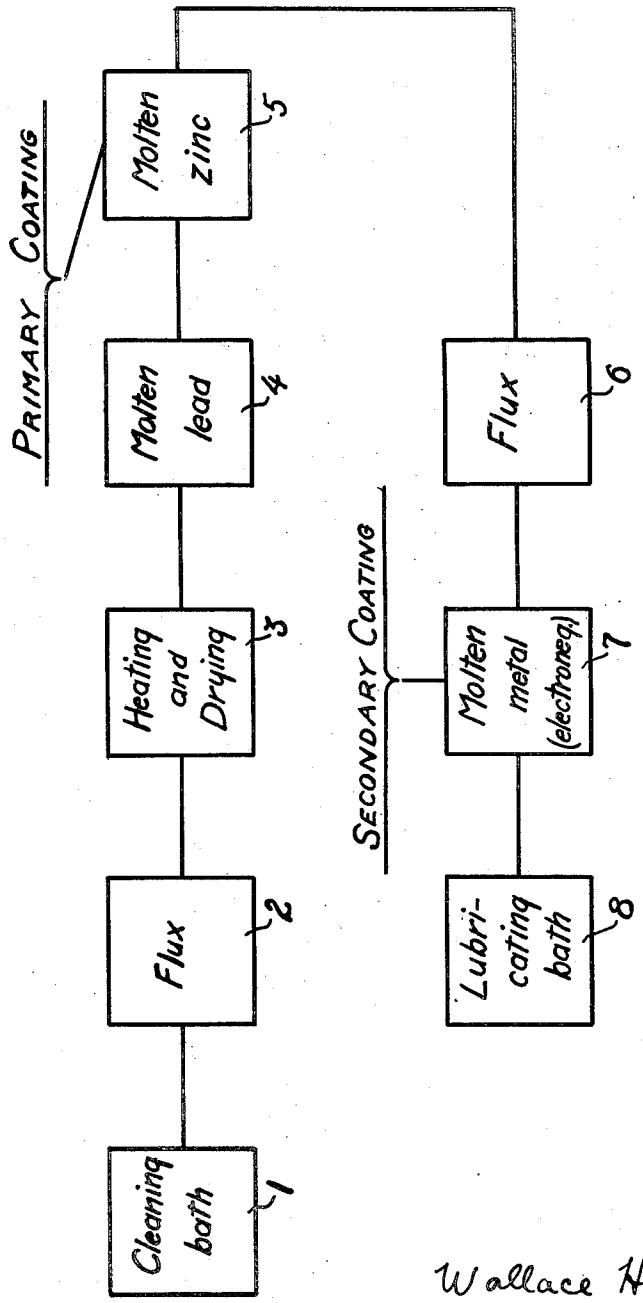


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## COATING PROCESS

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9 Claims. (Cl. 91—70.2)

This invention relates to a process for coating metal articles, particularly iron and steel articles, with a protective metal coating which is resistant to acids and other corrosive agents and to weather exposure, and to the coated article resulting therefrom.

The object of the invention, in general terms, is to provide an improved coating of the character described and such that the coated articles shall have longer life and give greater service than articles coated by galvanizing or any other process in general use heretofore.

A further object of the invention is to provide a coating process of the character described which is applicable not only to the coating of metallic sheets but also of wire, bars, rods, plates, pipes, bolts, and in general formed articles of all kinds fabricated from metal, such as iron or steel; and which provides a coating having sufficient ductility that the articles may be bent or shaped without damaging the coating.

It is a matter of common knowledge that a thick zinc coating is an effective protection for iron and steel articles against weather exposure but is of no practical value in resisting the action of acid or other corrosive agents. In order to obtain adequate protection against weather exposure, a coating of considerable thickness is essential, and by reason of the brittle character of zinc, such thick zinc coatings will not permit bending or fabrication of the coated article without fracture of the coating and consequent exposure of the iron or steel base, resulting in rusting and rapid deterioration of the article.

It is also a matter of common knowledge that lead and tin have great natural resistance to corrosion in general and possess considerable ductility so that coatings of lead or tin are adapted to withstand severe bending and fabricating operations without fracture. However, lead has little natural affinity for iron or steel and since both lead and tin are electro-negative to iron or steel, they do not provide adequate protection for iron and steel articles against corrosion when such articles are coated therewith.

In accordance with the process embodying the present invention, the article to be coated, for example an iron or steel sheet, wire, bar, plate, angle or pipe, is first given a coating, free of pinholes or openings, of zinc or zinc having a small admixture of tin, copper or antimony, said coat being electro-positive to iron or steel; then upon the primary electro-positive coating is applied a comparatively thick coating of lead or lead and tin, the primary coating forming a barrier between the iron or steel base and the secondary electro-negative coating. In this manner, a ductile coating is formed upon the article which has been found in actual practice to give protection against acids and other corrosive agents and exposure to the weather over long periods of time. The coatings are applied to the article by passing the same through, or immersing it in, a bath of the coating metal in molten state. If desired, the coated article after partially cooling may be passed through a bath consisting of a mixture or emulsion of oil, such as machine lubricating oil, and water. This step is merely for the purpose of lubricating the surface of the article and is used particularly when subjected to subsequent fabrication or shaping.

The remarkable results obtained by the process embodying the invention are believed to be in large part dependent upon the perfection of the primary or electro-positive coating because of the function of this coating as explained above. In order to attain the optimum results, the article to be coated is specially treated to obtain a desirable primary zinc coating of different character than that obtained by the ordinary galvanizing process.

In order to enable those skilled in the art to practice the invention, a detailed description of the preferred steps in the coating process is given by way of example with reference to the accompanying drawing, the single figure of which is a diagrammatic view illustrating the principal steps of the process.

The article to be coated, for example, an iron or steel sheet, wire, et cetera, is first cleaned in any suitable manner and coated with a flux. A cleaning bath 1 consisting of a solution of hydrochloric, sulphuric or hydrofluoric acid or a mixture of these acids may be employed. A hot 6 to 10% solution of hydrochloric acid is preferred because of its low sulphur content and because if the article is dipped in or passed through the flux without rinsing off the acid, the latter becomes a part of the flux and is suitable for that purpose. As a flux, a solution of ammonium chloride (10%) and copper chloride (½%) may be used. The article is removed from the flux bath 2 and heated in an oven 3 to a temperature of 300–350° F. This drives off the water of solution and leaves a deposit of chlorides on the article. Any equivalent heating means may be employed instead of the oven 3.

The hot, dry article is then passed through or immersed in a bath 4 of molten lead at a temperature of about 750–900° F. for a few seconds. For

light-weight articles in general, the bath 4 should be run cooler than for heavier articles. Any suitable metal may be employed in the bath 4 as the purpose of this step in the process is to heat the article and prepare the surface thereof to receive the primary zinc coating. Lead is preferred, however, as it is low in price, has the desired physical properties and does not alloy readily with zinc.

The article is then, while the lead adhering thereto is still molten and avoiding prolonged contact with air, passed through or immersed in a bath 5 of molten zinc at about the same temperature. In order to avoid contact with air, the molten zinc may be floated on the top of the lead bath so that the article may be drawn from the latter through the molten zinc. If desired, the zinc may contain a small proportion, less than 1%, of tin, copper or antimony to increase the toughness or otherwise improve the character of the zinc coating. When the article emerges from the zinc bath, the coating is immediately set, preferably by a cooling blast of air.

The primary coating formed in this manner is a continuous, adherent, uniform coating of medium thickness consisting essentially of zinc. A rather light coating is preferred in the case of sheets, wire and the like which are to be fabricated after coating whereas shaped articles are given a fairly heavy primary coating. The purpose of the lead bath is to preheat the article to the temperature of the zinc bath and to prepare the surface of the article so that a more adhesive zinc coating is obtained; the melting point of lead being 632° F., it drains away from the article as the latter passes through the zinc bath, and analysis shows that only a trace of lead is present in the primary coating.

The zinc coating obtained in this manner is of different character than that obtained by the usual galvanizing process. In such process, the sheets to be galvanized, after pickling, are fed wet and cold through a flux bath into the molten zinc. When the cold sheet passes into the flux and molten zinc, gas is formed which produces tiny blowholes in the coating when the sheet is removed from the zinc bath. Such a coating would be entirely unsatisfactory as a primary coating in the present process in which the said coating forms a barrier between the base and the secondary coating.

After the primary coating has set and while still hot, the article is passed through or immersed in a suitable flux, for example, a bath 6 of ammonium chloride, zinc chloride or copper chloride, or a mixture of these chlorides at an elevated temperature, say 700° F. or less. The article is then passed through or immersed in a bath 7 of molten lead or lead and tin at a temperature low enough to avoid melting the zinc primary coating. In the case of lead, a temperature of about 680° F. is suitable, and for lead and tin, a somewhat lower temperature may be used. A relatively thick secondary coating of lead or zinc and tin is thus formed upon the primary coating. The double coating adheres to the article and provides exceptional protection against corrosion and weather exposure while it is sufficiently ductile to permit bending or working of the article without fracturing the coating.

Where a tin and lead secondary coating is desired, the bath 7 may contain from 75% to 90% lead and from 10% to 25% tin. A larger proportion of tin may be used but the cost is increased thereby. Thus while a coating of tin alone may be formed by the process described, this would not be feasible from a commercial standpoint.

In the secondary coating bath, the lead or tin should be substantially pure. If this coating contains any zinc, for example, the zinc tends to segregate in spots, and at these points the rate of corrosion would be comparatively large. If a lead bath is used, zinc is removed therefrom by treating the bath frequently with sheet copper scrap. The bath is further purified from time to time by heating the same to a temperature of 950° F., at which temperature the impurities rise to the surface and may be removed. If the bath contains tin it may also be purified by boiling.

The coated article is removed from the lead bath and immediately cooled by an air blast or equivalent cooling means. In the case of sheets, the sheets may be passed through hollow rolls through which a cooling medium is circulated. The sheets reach the cooling rolls just as the coating sets and the rolls serve to increase the density of the coating and smooth the sheets. Coated wire is drawn through a layer of graphite to smooth and regulate the coating.

After the article has cooled sufficiently, it may be passed through an oil and water bath 8 for the purpose of lubricating the surface. This step may be omitted, particularly if the article is not to be subsequently fabricated.

It will be understood that the foregoing example of a coating process according to the invention is merely illustrative and the scope of the invention is not to be limited except as limitations are set forth in the appended claims.

I claim:

1. The process of coating iron and steel articles comprising the steps of first coating the surface of the article with a continuous, adherent, electro-positive coating consisting principally of zinc and then applying a coating of lead by immersing the article in a bath of molten lead while maintaining said bath substantially free from impurities and particularly free from electro-positive constituents such as zinc.

2. The process of coating metallic articles comprising the steps of immersing the article in a molten lead bath at a temperature of 750°–900° F., immediately transferring the article to and immersing same in a bath of molten zinc at 800°–900° F., coating the article with a suitable flux material, and finally immersing the article in a bath of molten material consisting of one of the group consisting of the metals lead and tin and an alloy consisting of lead and tin at a temperature below the melting point of zinc, while maintaining said last-mentioned bath substantially free from impurities and particularly free from electro-positive constituents such as zinc.

3. The process of coating metallic articles comprising the steps of applying a solution of fluxing material, heating the article sufficiently to drive off the water from said solution, immersing the hot, dry article in a molten lead bath at a temperature of 750°–900° F., transferring the article immediately to a bath comprising principally molten zinc at 800°–900° F., immersing the article in a bath of suitable flux material at an elevated temperature, and finally immersing the article in a bath of molten material consisting of one of the group consisting of the metals lead and tin and an alloy consisting of lead and tin at a temperature at or below 680° F., while maintaining said last-mentioned bath substantially free from

impurities and particularly free from electro-positive constituents such as zinc.

4. The process of coating iron and steel articles comprising the steps of heating the article in a bath to prevent contact with air to a temperature of 750°–900° F., immersing the article without prolonged contact with air in a bath consisting principally of molten zinc at a temperature of 800°–900° F., and then immersing the article in a bath of molten material consisting of one of the group consisting of the metals lead and tin and an alloy consisting of lead and tin at a temperature below the melting point of the zinc coating, while maintaining said last-mentioned bath substantially free from impurities and particularly free from electro-positive constituents such as zinc.

5. The process of coating iron and steel articles comprising the steps of immersing the article in a heating bath of molten metal having small affinity for iron and steel, said bath being at a temperature of 750°–900° F., transferring the article without substantial contact with air to a bath consisting principally of molten zinc at a temperature of 800°–900° F., then immersing the article in a bath of molten lead at a temperature below the melting point of the zinc coating, and treating the said bath of molten lead from time to time to remove zinc and other impurities therefrom.

6. The process of coating iron and steel articles comprising the steps of immersing the article in a heating bath of molten metal having small affinity for iron and steel, said bath being at a temperature of 750°–900° F., transferring the article without prolonged contact with air to a bath consisting principally of molten zinc, then immersing the article in a bath of an alloy consisting of seventy-five to ninety per cent lead and the balance tin, and treating the said bath of lead and tin from time to time to remove zinc and other impurities therefrom.

7. The process of coating iron and steel articles comprising the steps of fluxing the surface of the article, heating the article to an elevated temperature, applying a primary coating of zinc to the article while still hot, cooling the article sufficiently to set the primary coating, bathing the article with a hot fluxing solution, and then immersing the article in a bath of molten material consisting of one of the group consisting of the metals lead and tin and an alloy consisting of lead and tin at a temperature below the melting point of zinc, while maintaining said last-mentioned bath substantially free from impurities and particularly from zinc.

8. The process of coating iron and steel articles comprising the steps of preheating the article to a temperature approximating the melting point of zinc, immersing the article in a bath consisting principally of molten zinc, cooling the article sufficiently to set the primary coating of zinc so formed, immersing the article in a molten bath of lead at a temperature substantially below the melting point of zinc, and periodically removing any zinc which may accumulate in the said lead bath.

9. The process of coating iron and steel articles comprising the steps of heating the article, immersing the article in a bath consisting principally of molten zinc, cooling the article sufficiently to set the primary coating of zinc, then immersing the article in a molten bath of a final coating material consisting of one of the group consisting of the metals lead and tin and an alloy consisting of lead and tin at a temperature below the melting point of the primary coating, and treating the molten bath of the said final coating material from time to time to remove zinc and other impurities therefrom.

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