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HIGH STRENGTH ALUMINUM COATED STEEL

Wilhelm Schüll, Cologne-Dellbrück, and Clemens Eisenhuth, Cologne-Holweide, Germany, assignors to American Chain & Cable Company, Inc., a corporation of New York

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This invention relates to aluminum coated steel, and is particularly directed to the provision of an improved method for producing aluminum coated steel of high tensile strength. It is a particular object of the invention to produce high strength aluminum coated steel wire by a process which involves dipping the wire (or other shape) in molten aluminum to form the aluminum coating thereon. Satisfactory processes and equipment that can be used for hot dip aluminizing of wire have only recently been developed. Good coatings are formed by these processes, but with the limitation that the strength of the steel wire does not exceed about 170,000 lbs./sq. in. The production of aluminized steel wire of greater strengths is not possible by the processes heretofore proposed, for during aluminizing the strength of the wire is considerably reduced because of the high melting point of the aluminum bath. It has been attempted to counteract this wire strength loss by a subsequent drawing operation. This, however, has been only partly successful, as the aluminized steel wire is not structurally adapted to the extensive cold working necessary for developing a really high tensile strength (e.g., above 175,000 lbs./sq. in.). Thus, it has not been possible, by the processes presently known, to produce aluminized steel wire of greater strength than 170,000 lbs./sq. in.

Efforts also have been made to lessen the loss of strength accompanying the aluminizing of steel wire by keeping the temperature of the coating bath as low as possible through the addition of suitable metals, but important improvements have not yet been obtained by this approach.

This invention provides for the production of aluminized steel wire of high strength by passing the cleaned wire through a molten aluminum coating bath and drawing it in the same process. The invention departs, however, from procedures heretofore used in that the temperature of the bath is raised to above the values heretofore employed and is controlled in accordance with the carbon content of the wire passing through, so that the utmost possible alteration in the wire to an austenitic structure results.

Thus, in carrying out the new method, the bath of molten aluminum is heated to above the Ac_3 point of the wire or other steel shape to be coated. The wire (or other shape) then is immersed in such bath, and is retained therein long enough to be heated to above its Ac_3 temperature. Thus, upon withdrawal of the steel wire or other shape from the molten aluminum, it is in the substantially fully austenitic condition. It is cooled in air substantially to room temperature and thereafter severely worked to develop the desired high tensile strength (above 175,000 lbs./sq. in.).

In order to avoid the necessity of supplying heat to the bath to heat the steel to above its Ac_3 point, the wire or other shape may be preheated in a protective gas atmosphere to a temperature near or above its Ac_3 point. The resulting hot wire then is introduced into the molten aluminum bath. Preheating the wire not only reduces the need for supplying heat to the molten aluminum, but also reduces the time the wire need be held in the molten aluminum bath to be heated to above its Ac_3 transformation point. Indeed, in some cases it is practical and desirable to preheat the wire to above its Ac_3 point and to introduce it at such temperature into the heated molten aluminum. All the heat required to maintain the aluminum bath at the desired temperature may in some cases be supplied in this fashion. Even in such case, however, the molten aluminum must be heated to above the Ac_3 point of the wire to avoid quenching and hardening it.

The actual temperature to which the molten aluminum must be heated depends of course on the carbon content of the steel wire, for the Ac_3 point depends on carbon content. For example, a steel wire containing 0.5% carbon has an Ac_3 point of about 1435° F.; and a steel wire containing about 0.85% carbon has an Ac_3 point of about 1365° F. The aluminum bath is, in accordance with the invention, heated to above such temperature, depending on the particular steel being aluminum coated.

When the wire is preheated to near or above its Ac_3 point, it should be protected by a non-oxidizing atmosphere to prevent substantial oxidation of its surface prior to its introduction into the molten aluminum. The aluminum coating which adheres to the wire as it is withdrawn from the bath protects it from oxidation, and hence the wire can be allowed to cool in air without suffering any undesirable chemical attack.

By means of the method of this invention it is possible to produce aluminum coated high carbon steel wires of very high tensile strength. For example, aluminum coated steel wires containing 0.5% carbon having tensile strengths exceeding 200,000 lbs./sq. in., and similar wires containing 0.85% carbon having tensile strengths substantially exceeding 250,000 lbs./sq. in., can readily be produced. Steel wires of such strength, and possessing a high degree of hardness, are eminently suitable for use as spring wire, in high strength bridge cables and wire ropes, and for other purposes requiring steel of very high tensile strength. Moreover, these high strength products possess the notable resistance to corrosion that characterizes aluminum coated articles.

Following is an example of the method of this invention. A steel wire containing 0.85% carbon, 0.102 inch in diameter, was heated in a conventional patenting furnace to a temperature of about 1550° F. The heated wire was rapidly transferred to a bath of molten aluminum maintained at a temperature of about 1370° F. The wire was then withdrawn from the aluminum bath with an adherent aluminum coating and was cooled in air to room temperature. Thereafter, it was cold drawn to a final diameter of 0.039 inch. The drawn wire had a tensile strength of 265,000 lbs./sq. in. and withstood 30 full turns when twisted about its axis over a length of 100 times its diameter.

We claim:

1. The method of producing high strength aluminum coated steel which comprises heating a bath of molten aluminum to a temperature above the Ac_3 point of the steel, immersing the steel in such bath to form an aluminum coating thereon, withdrawing the steel from the bath in the substantially fully austenitic condition, cooling the steel substantially to room temperature, and severely working the cooled aluminum-coated steel to develop therein a high tensile strength.

2. The method of producing high strength aluminum coated steel wire which comprises heating a bath of molten aluminum to a temperature above the Ac_3 point of the wire, immersing the wire in such bath to form an aluminum coating thereon, withdrawing the wire from the bath in the substantially fully austenitic condition, cooling the wire substantially to room temperature, and severely working the cooled aluminum coated wire to develop therein a high tensile strength.

3. The method of producing high strength aluminum coated steel wire which comprises heating a bath of molten

aluminum to a temperature above the Ac_3 point of the wire, preheating the wire to a temperature near its Ac_3 point, immersing the preheated wire in the molten aluminum and withdrawing it therefrom only after it has attained a temperature above its Ac_3 point and is in substantially the fully austenitic condition, cooling the wire substantially to room temperature, and severely working the cooled aluminum coated wire to develop therein a high tensile strength.

4. The method of producing high strength aluminum coated steel wire which comprises heating a bath of molten aluminum to a temperature above the Ac_3 point of the wire, preheating the wire in a protective gas atmosphere to a temperature near its Ac_3 point, immersing the preheated wire in the molten aluminum and maintaining it therein until it is heated to above its Ac_3 point, withdrawing the wire from the bath in the substantially fully austenitic condition, cooling the wire substantially to room temperature, and severely working the cooled aluminum coated wire to develop therein a high tensile strength.

5. The method of producing high strength aluminum

coated steel wire which comprises heating a bath of molten aluminum to a temperature above the Ac_3 point of the wire, preheating the wire in a protective gas atmosphere to a temperature above its Ac_3 point, passing the thus-heated wire through the bath of molten aluminum and withdrawing it therefrom in the substantially fully austenitic condition, cooling the resulting aluminum coated wire in air substantially to room temperature, and thereafter severely working the wire to develop therein a high tensile strength.

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