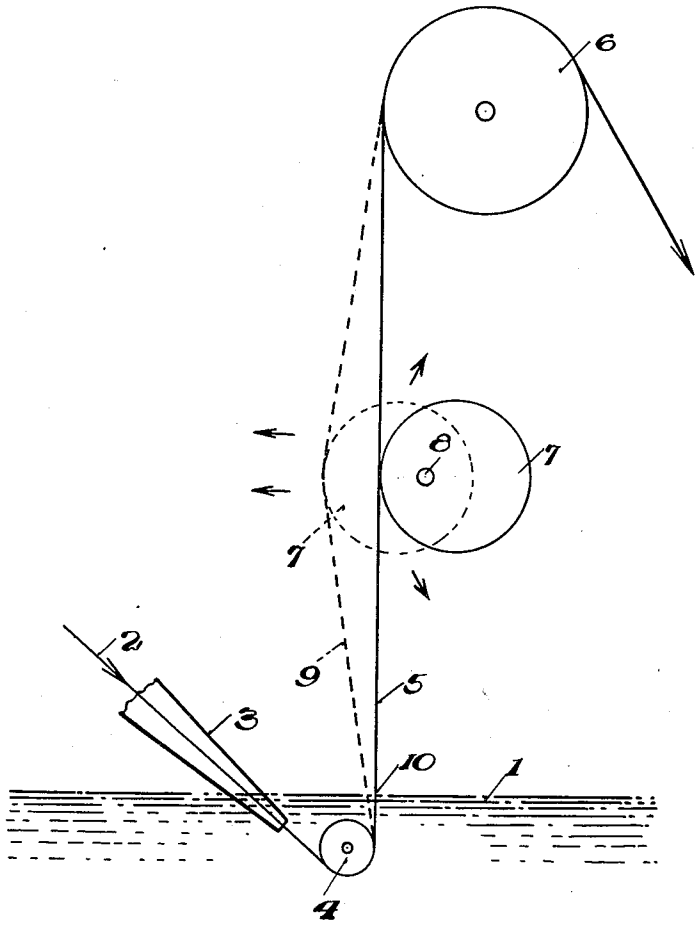
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METHOD OF COATING STRIPS

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Inventor

Jean V. Giesler.

By Cameron, Kerkam & Sutton

Attorneys

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METHOD OF COATING STRIPS

Jean V. Giesler, Knoxville, Tenn., assignor, by mesne assignments, to Reynolds Metals Company, New York, N. Y., a corporation of Delaware

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This invention relates to the coating of metal strips, ribbons, bands and the like, and more particularly to the coating of a strip or the like of suitable base metal, such as iron or steel, with metals of the general character represented by aluminum.

Coating metals of the type referred to, especially aluminum which oxidizes readily when in contact with the air particularly when in a molten condition, form a relatively tenacious oxide film at the surface of the molten coating bath. It has heretofore been pointed out in the patent to Whitfield and Sheshunoff, Patent No. 2,135,652, granted November 8, 1938, that this film is probably the cause and source of the difficulties heretofore experienced in obtaining relatively thick coatings of aluminum and coatings of relatively uniform thickness. The surface film apparently acts somewhat like a scraper to limit the amount of molten aluminum that will adhere to the emerging strip. Furthermore, this film apparently tends to adhere to the emerging strip and to be drawn temporarily along with the coating until the resistance to the drag of this film causes a rupture of the film whereby portions of the film are left on the coated metal, on the one hand, while the ruptured film sliding down the emerging metal, under the elastic action of the film after each rupture, tends to wipe some of the coating metal off of the emerging base metal, on the other hand. Hence experience has demonstrated that it is very difficult to obtain an aluminum coating which is relatively thick or which is of substantially uniform thickness, appearance and other physical characteristics.

In the aforesaid patent to Whitfield and Sheshunoff relatively thick and uniform coatings of aluminum have been obtained by setting up a continuous series of small waves which run across the surface of the bath at its junction with the emerging metal, such waves being obtained by impinging a stream of air on the surface of the molten bath.

It is an object of this invention to provide a novel method for obtaining a relatively thick and substantially uniform layer of coating metal which avoids the necessity of maintaining a blast or stream of air on the surface of the molten bath and which is effective in obtaining substantially uniform coatings of controlled thickness.

Another object of this invention is to provide a novel method for avoiding alternately thick and thin areas of coating such as heretofore encountered in the coating of ferrous metal with aluminum.

Another object of this invention is to provide a novel method for avoiding dark streaks at the surface of the coated metal such as heretofore encountered in the coating of ferrous metal with aluminum.

Another object of this invention is to provide a novel method for coating ferrous metal with aluminum whereby relatively thick coatings may be obtained.

Another object of this invention is to provide a novel method for coating ferrous metal with aluminum whereby coatings of substantially uniform thickness may be obtained.

Another object of this invention is to provide a novel method for coating ferrous metal with aluminum by which a coating of substantially uniform appearance and brightness may be obtained.

Other objects will appear as the description of the invention proceeds.

In conformity with the present invention the strip or the like to be coated is passed in any suitable way through the coating bath and caused to emerge therefrom at a large angle with respect to the surface of the bath, preferably an angle which approximates a right angle, and the emerging strip is caused to vibrate in any suitable way, and preferably in a direction substantially at right angles to the face of the strip, so that said strip at the surface of the bath shall have a substantial magnitude of movement. The rate of vibration should be at least thirty vibrations per minute, and the magnitude of vibration should be such as to cause the emerging strip to move in the plane of the surface of the bath through at least one eighth of an inch. However, as will be apparent to those skilled in the art, the magnitude and rate of vibration may be varied, one with respect to the other, as the magnitude of vibration may be somewhat reduced as the rate of vibration is increased while the magnitude should be increased if the rate of vibration decreases to near the allowable limit. Furthermore the temperature of the metal, and therefore its fluidity, and the rate at which the strip is run through the bath are factors which will permit some variation of both the rate and the magnitude of vibration. Experience to date, however, has demonstrated that if the strip, where it emerges from the bath, is vibrated at a rate approximating sixty vibrations per minute and the magnitude of vibration is from one eighth to one fourth inch in extent, a substantially uniform coating of aluminum on ferrous base metal can be obtained, and this coating will be materially thicker than or a plurality of times as thick as that obtained when the strip is merely passed through the bath without agitation of the surface in accordance with the process disclosed in the aforesaid patent to Whitfield and Sheshunoff.

I am aware that it has heretofore been proposed to vibrate a woven wire fence fabric after it emerges from a coating bath, so as to shake from the fabric drops of coating metal that tend to gather at the knots of the fabric. Such a pro-

cedure, however, is incapable of accomplishing the results obtained by the present invention for a number of reasons, among which may be noted that, in order to shake loose the drops and cause them to fall back into the bath by gravity, rather than flow down the surface of the emerging fabric, the fabric is vibrated while disposed at a small angle to the horizontal, whereas in accordance with the present invention the emerging strip should approximate as nearly as convenient to a right angle to the surface of the bath; also, with such prior practice the maximum vibration should occur where the drops are to be shaken loose, and any vibration at the surface of the bath is of no significance, but rather tends to a decrease in the efficiency of the process, whereas with the present invention the maximum vibration should occur as nearly as may be convenient to the surface of the bath, and the displacement of this point of maximum vibration outside of the surface of the bath arises from mechanical difficulties that would occur if the maximum vibration were produced at the surface of the bath.

The process of the present invention can be carried out by means of any suitable apparatus which will set up the desired magnitude and rate of vibration at the junction of the emerging strip with the surface of the bath. The resistance to the movement of a vibration-producing means immersed in the bath, owing to the viscosity of the molten metal, renders it desirable as a practical matter to have the vibration-producing means coact with the strip after it emerges from the bath, although vibration of the strip by means in or at the surface of the bath is within the contemplation of the present invention. The application of the vibration-producing means to the strip too close to the surface of the bath may defeat the purpose of increasing the thickness of the coating because tending to wipe the coating metal off of the emerging strip before it has had a chance to set sufficiently. Therefore as a practical matter, I prefer to apply the vibration-producing means to the emerging strip at such a distance above the surface of the bath that said vibration-producing means will not wipe any of the coating metal off of the emerging strip but, with this limitation, to place the vibration-producing means as close to the surface of the bath as is feasible. How far above the surface of the bath the vibration-producing means must be disposed can be readily determined once the size of the strip, its speed of movement and the temperature of the bath have been determined, a higher temperature of the bath, or a larger volume of metal of the coated strip, or a higher rate of movement, requiring more time for the coating to set than when the temperature of the bath is nearly the melting point of the aluminum or the mass of metal is smaller or the rate of movement is lower.

As it is desirable in order to obtain a ductile or malleable strip that the dispersion of the aluminum and iron into each other be discontinued promptly after the strip emerges from the bath, the vibration-producing means may be associated with or constitute a part of the quenching means employed to discontinue said dispersion. This association of the quenching means with the vibration-producing means also has the further advantage that the quenching at this location tends to eliminate the danger of the vibration-producing means scrapping off or displacing the coating.

While any suitable means may be provided for effecting the vibration of the emerging strip, as a pusher rod acting to push the strip back and forth, as well as other expedients known to the art, I prefer to effect the vibration of the strip by the use of at least one roller mounted on an eccentric axis and cooperating with at least one face of the emerging strip to positively move the strip back and forth through its vibratory path. One suitable apparatus of the type referred to is illustrated on the accompanying drawing, which shows diagrammatically a suitable apparatus for practicing the present invention, and wherein a single roller cooperating with one face of the emerging strip is used to produce the desired vibration, but it will be apparent that any other suitable vibration means may be used in place of that illustrated.

Referring in detail to the drawing, 1 designates diagrammatically the surface of any suitable coating bath, preferably a bath of molten aluminum. The strip or the like of base metal 2, which may be of any suitable width and thickness and constitution but which is preferably a ferrous strip, enters the coating bath through a nozzle 3 which terminates below the surface of the bath, and then passes around a rotatable roller diagrammatically indicated at 4, and thence upwardly in nearly if not quite a vertical plane as illustrated at 5, so as to be approximately at right angles to the surface of the bath, and then to and over a guide roller 6. Intermediate the guide roller 6 and the surface of the bath, and as near to the surface of the bath as is feasible under the principles heretofore explained, is an eccentric roller 7 rotatable on axis 8 and driven in any suitable way and at any suitable speed to move the strip 5 back and forth between the dotted line 9 and the full line positions to produce the desired vibratory movement at the intersection 10 of the surface of the bath with the emerging strip. As heretofore pointed out, the rate of vibration should at least be thirty per minute, and is preferably on the order of sixty a minute or more, and the eccentrically mounted roller 7 is accordingly rotated at the desired speed of rotation to effect this rate of vibration. The eccentricity of the roller 7 will vary with the height above the surface of the bath but it should be such that the strip at the junction 10 of the strip with the surface of the bath is positively moved through a distance of at least one eighth of an inch and preferably on the order of one fourth of an inch or more.

In accordance with the preferred embodiment of the present invention the vibration-producing means has associated therewith suitable quenching means. To this end the roller or rollers 7 may be cooled in any suitable way, as by circulating a cooling medium therethrough, or any other suitable quenching means may be associated with the strip as before explained.

Experience has demonstrated that a ferrous strip coated with aluminum in accordance with the method herein set forth produces a coated strip wherein the aluminum coating may be several times that obtainable when the vibration-producing means is omitted, while the coating is of substantially uniform thickness and of substantially uniform brightness, without the variations in thickness and light and dark areas that have heretofore characterized aluminum coated ferrous metal when it is merely drawn through a coating bath.

It will therefore be perceived that by the pres-

ent invention a novel method of coating ferrous metal with aluminum has been provided which avoids the necessity of impinging a blast or jet of air on the surface of the metal and which at the same time produces a substantially uniform coating of substantially uniform characteristics.

While the present invention has been described particularly by reference to the coating of ferrous metal with aluminum, and it is possessed of particular utility when so used because of the difficulties heretofore encountered in satisfactorily coating ferrous metal with aluminum, it will be apparent that the present invention is also available for coating other metals with other coating metals presenting like or similar problems. Reference is therefore to be had to the appended claims for a definition of the invention.

What is claimed is:

1. In the method of producing relatively thick and uniform coatings of metal on strips or the like of base metal passed continuously through a molten bath of the coating metal, the steps of moving the strip being coated through the bath and out of the molten metal at a large angle on the order of a right angle to the surface of the bath and maintaining the strip within the molten metal at and adjacent to the surface thereof under a substantial vibration at an angle to the face of the moving strip so that the surface of the molten metal where the strip is withdrawn therefrom is kept under substantial agitation.

2. In the method of producing relatively thick and uniform coatings of metal on strips or the like of base metal passed continuously through a molten bath of the coating metal, the steps of moving the strip being coated through the bath and out of the molten metal at a large angle on the order of a right angle to the surface of the bath and maintaining the strip within the molten metal at and adjacent to the surface thereof under a substantial vibration at an angle to the face of the moving strip so that the surface of the molten metal where the strip is withdrawn therefrom is kept under substantial agitation, the magnitude of movement of the strip at the surface of the bath being on the order of one eighth to one fourth of an inch.

3. In the method of producing relatively thick and uniform coatings of metal on strips or the like of base metal passed continuously through a molten bath of the coating metal, the steps of moving the strip being coated through the bath and out of the molten metal at a large angle on the order of a right angle to the surface of the bath and maintaining the strip within the molten metal at and adjacent to the surface thereof under a substantial vibration at an angle to the face of the moving strip so that the surface of the molten metal where the strip is withdrawn therefrom is kept under substantial agitation, the rate of vibration being at least thirty vibrations per minute.

4. In the method of producing relatively thick and uniform coatings of metal on strips or the like of base metal passed continuously through a molten bath of the coating metal, the steps of moving the strip being coated through the bath and out of the molten metal at a large angle on the order of a right angle to the surface of the bath and maintaining the strip within the body of the molten metal at and adjacent to the surface thereof under a substantial vibration at an angle to the face of the moving strip so that the surface of the molten metal where the strip is withdrawn therefrom is kept under substantial agitation, and quenching said strip after it leaves the surface of the bath and at least by the time it reaches the vibration producing means.

5. In the method of producing relatively thick and uniform coatings of aluminum on ferrous strips or the like passed continuously through a bath of molten aluminum, the steps of passing the strip to be coated through the bath and withdrawing the same from the molten aluminum at approximately a right angle to the surface thereof and vibrating the strip above the surface of the bath at substantially right angles to the face of the strip to produce a substantial vibratory movement of the strip within the molten aluminum at and adjacent to the surface thereof and thereby maintain the surface of the molten aluminum in substantial agitation.

6. In the method of producing relatively thick and uniform coatings of aluminum on ferrous strips or the like passed continuously through a bath of molten aluminum, the steps of passing the strip to be coated through the bath and withdrawing the same from the molten aluminum at approximately a right angle to the surface thereof and vibrating the strip above the surface of the bath at substantially right angles to the face of the strip to produce a substantial vibratory movement of the strip within the molten aluminum at and adjacent to the surface thereof and thereby maintain the surface of the molten aluminum in substantial agitation, the magnitude of vibration at the surface of the molten aluminum being on the order of one eighth to one fourth of an inch.

7. In the method of producing relatively thick and uniform coatings of aluminum on ferrous strips or the like passed continuously through a bath of molten aluminum, the steps of passing the strip to be coated through the bath and withdrawing the same from the molten aluminum at approximately a right angle to the surface thereof and vibrating the strip above the surface of the bath at substantially right angles to the face of the strip to produce a substantial vibratory movement of the strip within the molten aluminum at and adjacent to the surface thereof and thereby maintain the surface of the molten aluminum in substantial agitation, the rate of vibration being at least thirty vibrations per minute.

8. In the method of producing relatively thick and uniform coatings of aluminum on ferrous strips or the like passed continuously through a bath of molten aluminum, the steps of passing the strip to be coated through the bath and withdrawing the same from the molten aluminum at approximately a right angle to the surface thereof and vibrating the strip above the surface of the bath at substantially right angles to the face of the strip to produce a substantial vibratory movement of the strip within the molten aluminum at and adjacent to the surface thereof and thereby maintain the surface of the molten aluminum in substantial agitation, and quenching said strip after it leaves the surface of the bath and at least by the time it reaches the vibration producing means.

JEAN V. GIESLER.