March 19, 1968 W. D. POOLE 3,374,159

MARKING OF STEEL STRIP ELECTROLYTICALLY USING ELECTROLYTE ADHERING TO THE STRIP

Filed Feb. 9, 1965 2 Sheets-Sheet 1

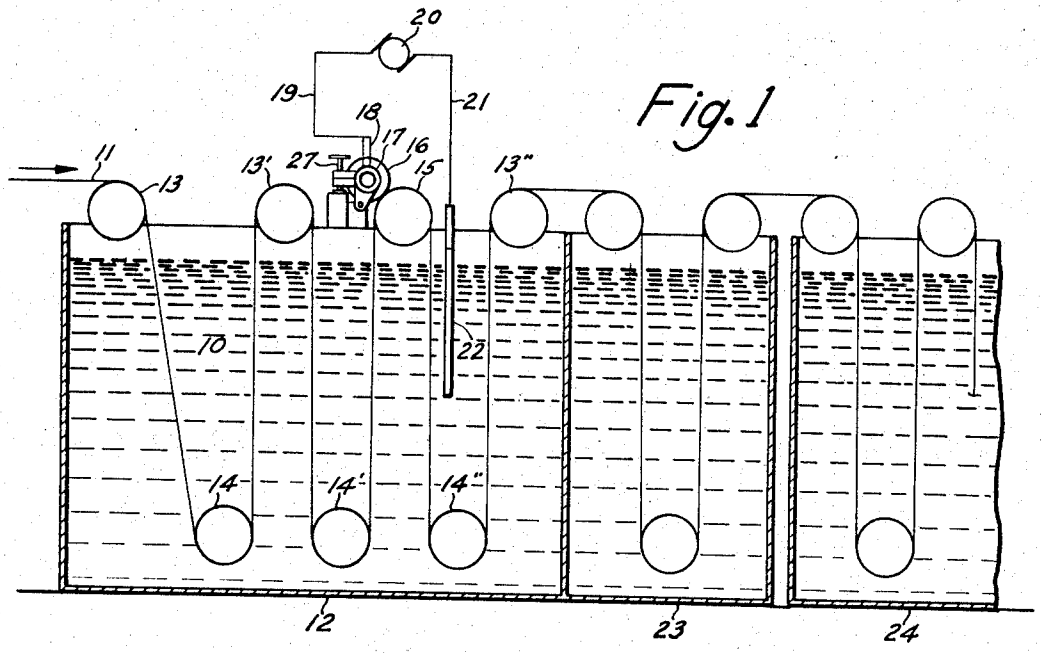


Fig. 1

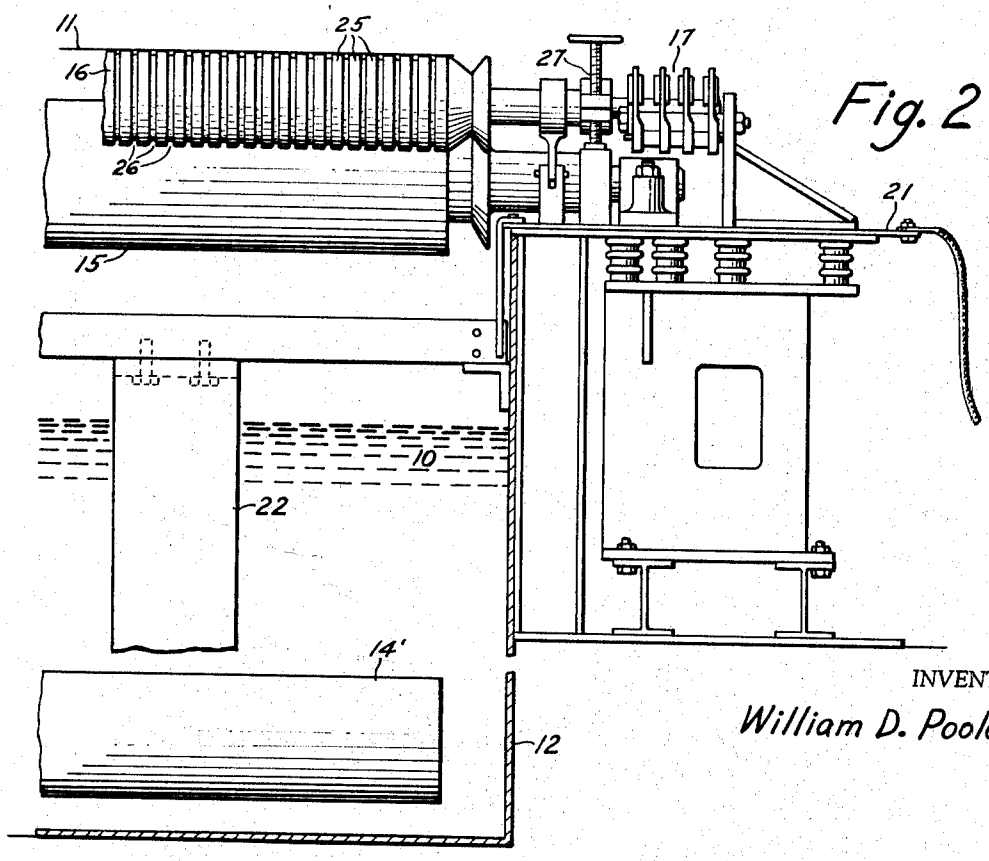


Fig. 2

INVENTOR

William D. Poole

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Fig. 3

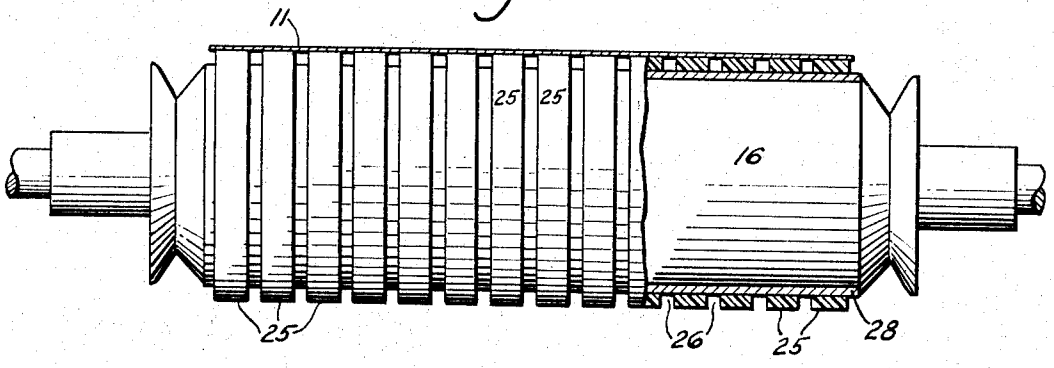
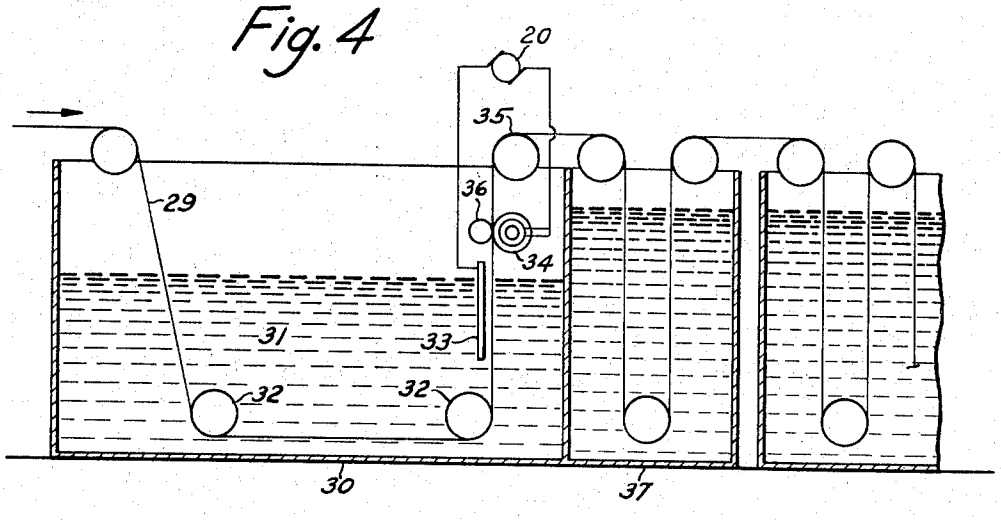


Fig. 4



INVENTOR

William D. Poole

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MARKING OF STEEL STRIP ELECTROLYTICALLY USING ELECTROLYTE ADHERING TO THE STRIP

William D. Poole, Center Valley, Pa., assignor to Bethlehem Steel Corporation, a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

In a method of marking strip, a metal strip is withdrawn from a pickling bath, the strip carrying with it a film of pickling solution. The wet strip makes physical contact with a marking roll having electrically conductive portions and raised electrically non-conductive portions on its surface. Current from a current source passes by way of an electrode in the pickling solution to the strip as anode, and thence through the liquid film on said strip to the electrically conductive portions of the marking roll and back to the power source. Sufficient current is supplied to develop a light etch on the strip in the pattern of the electrically conductive roll surface.

This invention relates to the marking of steel strip, and more specifically to the marking of strip which is subsequently given a coating of tin.

In the manufacture of electrolytic tinplate, it is desirable to be able to positively and accurately identify the tinplate with a specific producer, even after the tinplate has been fabricated into finished commercial articles. Markings for such identification should be placed upon the basis metal strip in a permanent form, although it is requisite that the intensity of the mark be such that it will not be noticeable after the strip has been commercially coated with tin. With a permanent marking on the basis metal, fabricated tinplate can be identified as to source by carefully removing the tin coating by appropriate chemical or electrochemical means and exposing the underlying steel which carries the identifying mark on its surface.

Tin coatings are generally applied by various electrolytic methods in coating weights ranging from 0.10 to 1.35 pounds of tin per base box. A base box (B.B.) represents 217.78 square feet of sheet or strip surface, each side. The thickness of the tin coating on the most popular grade of electrolytic tinplate, normally referred to as No. 25 tinplate (0.25 pound of tin per B.B.) is approximately 0.000015 inch. The extreme thinness of such tin coatings points up the problem involved in obtaining, and being able to control the intensity of, a permanent marking which will be visible upon removal of the coating, but which will not degrade the finished tinplate by showing through the coating.

A principal object of this invention is to provide a controllable method by which a permanent, but relatively light, mark can be produced on steel strip.

Another object is to produce uniform markings, either continuously or at regular intervals, throughout the entire length of the strip.

A further object is to provide marking means which can be adjusted readily, and which can be removed or replaced without any disruption of the strip line.

I have found that the foregoing objects can be accomplished by directing an electrical current to a moving, continuous steel strip, as the strip moves out of an electrically conductive solution, and contacting the strip with a contact roll having a perforate non-conducting coating. The moving strip, as it emerges from the solution, carries on its surface a uniformly distributed film of solution

which is allowed to fill the indentations or interstices in the non-conductive coating of the contact roll, thereby forming an electrolytic cell comprising the strip surface, the solution and the conductive surface of the contact roll at the perforate locations. As the strip is made to act as anode, the current may be appropriately regulated by suitable auxiliary means so that a light etch will be imposed upon the surface of the strip at any point of contact where an electrolytic cell is formed. The configuration of the etch, or marking, can be any form desired, and can be either continuous, as, for example, a straight line, or some interrupted, sequential pattern.

For a more complete understanding of the present invention, reference is made to the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic side elevation showing the manner by which a complete electrical circuit is made with the strip as anode.

FIG. 2 is a partial elevation at one end, of an anode, rolls and auxiliary equipment.

FIG. 3 is a longitudinal view, partly in section, of a contact (marking) roll with a perforate coating.

FIG. 4 is a schematic side elevation showing a variation of the structure depicted in FIG. 1.

Referring specifically to FIG. 1 a continuous steel strip **11** is introduced into an acid pickling tank **12** where it is guided around rubber-coated rolls **13**, **14**, **13'** and **14'** to clean the strip surface in the well-known manner of immersion acid pickling. From roll **14'**, the strip travels to rubber-coated carrying roll **15**, passing around roll **15** and between this roll and contact (marking) roll **16**. As strip **11** leaves roll **15** in a downward path, the strip is energized by current flowing from anode **22**, and supplied to the anode by a motor-generator **20** via conductor shown as line **21**. The current picked up by the strip from anode **22** travels back through the strip to a point where marking roll **16** contacts the strip. Roll **16**, having a width of 42 inches and diameter of about 9 inches, is composed of mild steel clad with lead-silver alloy, and the cladding is in turn coated with a series of non-conductive teflon sleeves, each about 1¼ inches in width. The sleeves, shown at **25** in FIG. 3, are spaced apart from each other by a spacing distance of about one sixteenth of an inch, creating voids **26**. In the same figure, cladding is indicated at **28**. As the strip is withdrawn from the pickling solution **10** at roll **15**, a thin film of solution adheres to the strip on the side away from roll **15**. When roll **16** contacts the strip, pickling solution on the strip is forced up into voids **26**, and the current traveling through the strip from anode **22**, leaves the strip at this point and takes a course through the solution held in the voids to the conductive alloy surface of roll **16**. From there the current is removed from the roll by collector head **17** and bus bar **18**, and travels back to the current source **20** via conductor shown as line **19**. From the pickeling tank, the strip enters rinse tank **23** by way of rolls **14''** and **13''**, and from there it is introduced into a tin electroplating tank **24**.

From the foregoing it will be seen that an electrolytic cell is formed at each void where roll **16** contacts the strip. In the formation of each individual cell, the strip acts as anode, and the metal surface of roll **16** forms the cathode, with the momentarily encapsulated pickling solution providing the electrolyte. As the strip acts as the anode, sufficient current passing through the system will electrochemically etch the steel strip at each point of cell contact.

As referred to previously, the degree of etch must be controlled so as to be concealed by the amount of tin coating ultimately plated on the strip.

By this invention, the etch at any one location on the strip will be developed by a point contact of the contact roll **16**, and for this reason control of the etch becomes a simple matter of supplying sufficient current for the brief interval of contact. The speed of the strip will be from about 400 feet per minute and upwards, thus restricting contact time for etching to much less than one second. To control the intensity of electrochemical action, the source of DC marking current **20** is synchronized with the strip line speed controls for automatic rough adjustment. Precise adjustment of the current supplied to the system is made manually by vernier-controlled rheostat, not shown. Once the desired degree of etching has been determined, the proper current flow can be maintained constant by the comparable rheostat setting.

While alternative methods may be used for supplying current to the strip, such as, for example, a current-carrying roll with the necessarly collector head and brush equipment, which would contact the strip outside the bath, the method shown in the example given above, wherein the current is supplied to the strip by means of a non-consumable anode submerged in the electrolyte, offers a simple form of construction which is practically free of maintenance problems. The anode employed in a sulfuric acid pickling bath may be constructed of lead or lead-silver alloy.

While in the example given above, the electrolyte comprises a sulfuric acid pickling solution having a concentration of from about 1 to 10% by weight, it will be apparent that other relatively dilute mineral acids may be used as the electrolyte, the only requirements being that a film of acid solution covers the entire strip width as the strip emerges from the acid solution and contacts the marking roll, and that the composition of the submerged anode and metal cladding of the marking roll be adapted so as to be non-consumable in the mineral acid employed.

The strip-carrying roll, which normally operates immediately above the acid electrolyte is normally rubber or synthetic rubber covered.

Teflon or similar plastic material is preferred as the non-conductive material for the marking roll because of its excellent seating properties on the roll; however, other non-conductive materials such as compounded rubber may be used.

The surface of the marking roll must be resistant to dilute acid, electrically conductive and resistant to electrolytic action in the dilute acid electrolyte. The lead-silver alloy cladding (½% silver) of the example meets these requirements admirably for dilute sulfuric acid. Other metals which could be substituted for the marking roll surface, when employing this acid, are chemically pure lead or aluminum bronze.

Referring to FIG. 2, manual pressure regulating means **27** and collector head means **17** are shown at their location on the bearing arm extension of marking roll **16**. It may be necessary to provide a collector head at one end of the marking roll only.

The positioning of roll **16** above and adjacent roll **15**, in the manner shown in FIGURES 1 and 2, has been found to produce the most efficient type of operation for either a skein type or horizontal type of strip treating line. However, in either type of line, the contact, or marking roll could be placed on the underside of the strip, and away from, and ahead of the carrying roll, as shown in FIG. 4. In FIG. 4, the strip **29** is passed through pickling tank **30**, containing pickling solution **31**, by way of sinker rolls **32**, and picks up current from anode **33** submerged in the bath. The charged strip, carrying a film of electrolyte, then passes over marking roll **34**, where the current leaves the strip by means of the electrolytic cell formed in the interstices of the non-conductive coating of roll **34**, as in the previous example, the etching taking place on the underside of the strip in this case. The strip then passes over insulated carrying roll **35** to the rinse tank **37**. In this type of operation, it is desirable to provide a back-up roll **36** in order to maintain proper contact of marking roll **34** with strip **29**.

The marking roll is a non-carrying roll, making only a point contact with the strip. In the case of a relatively slow moving strip plating line, such as an alkaline tinplating line, the marking roll may be an idler-type roll. For use on a high speed horizontal type of line, the marking roll should be driven to reduce friction. In any case, the marking roll is never used as a strip-carrying roll.

In applying an etch to the strip by use of a marking roll in the manner of the described invention, several advantages will become apparent. As the etch on the strip is made by a point electrolytic contact with the contact roll, there is no chance for a build-up of gas pressure in the individual electrolytic cells, as coud occur if the strip were wrapped around a considerable part of the contact roll. Also, because of the point contact, the interstices in the contact roll surface, in which the electrolytic cells are formed, are self-cleaning, so that there is no build-up of dirt particles therein which could result in various inffiiencies.

In addition, this type of roll can be removed or replaced without any distortion of the path of travel of the strip. Sensitive pressure adjustment can be made on the contact roll, which in turn aids in producing the most efficient etching.

While the method of the invention is particularly adapted for marking tinplate stock for later identification, it will be apparent that steel strip so marked could be used as the basis metal for any type of metallic coating, whether applied electrolytically, by immersion, or by other means. Furthermore, electrically conductive metals other than steel can be etched by this treatment.

I claim:

1. The method of marking metal stock which comprises removing metal strip from an aqueous solution by means of a carrying roll in a manner which permits a film of said solution to be retained on the strip and which thoroughly wets the strip, contacting one side of the wet strip with a non-carrying metal marking roll, contacting the opposite side of the strip adjacent the marking roll with a back-up roll, said marking roll having bare portions and electrically non-conductive coated portions on its surface, said coated portions having sufficient thickness so that said bare portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said bare portions of the surface of the metal marking roll to the metal surface of said roll, and then to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said bare portions.

2. The method of marking metal stock which comprises removing metal strip from an aqueous solution by means of a carrying roll in a manner which permits a film of said solution to be retained on the strip and which thoroughly wets the strip, contacting the strip on the side away from said carrying roll with a non-carrying metal marking roll located adjacent said carrying roll, said marking roll having bare portions and electrically non-conductive coated portions on its surface, said coated portions having sufficient thickness so that said bare portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said bare portions of the surface of the metal marking roll to the metal surface of said roll, and then to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said bare portions.

3. The method of marking metal stock which comprises removing steel strip from an aqueous solution by means of an electrically insulated carrying roll in a manner which permits a film of said solution to be retained on

the strip and which thoroughly wets the strip, contacting the strip on the side away from said carrying roll with a non-carrying corrosion-resistant metal marking roll located adjacent said carrying roll, said marking roll having bare portions and electrically non-conductive coated portions on its surface, said coated portions having sufficient thickness so that said bare portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said bare portions of the surface of the metal marking roll to the metal surface of said roll, and then to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said bare portions.

4. The method of marking metal stock which comprises removing steel strip from an aqueous solution by means of an electrically insulated carrying roll in a manner which permits a film of said solution to be retained on the strip and which thoroughly wets the strip, contacting the strip on the side away from said carrying roll with a non-carrying corrosion-resistant metal marking roll located adjacent said carrying roll, said marking roll having bare portions and electrically non-conductive coated portions on its surface, said coated portions having sufficient thickness so that said bare portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said bare portions of the surface of the metal marking roll to the metal surface of said roll, and then to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said bare portions, and then coating the strip with a non-ferrous metal.

5. The method of marking metal stock which comprises removing metal strip from an aqueous solution by means of a carrying roll in a manner which permits a film of said solution to be retained on the strip and which thoroughly wets the strip, contacting one side of the wet strip with a metal marking roll located above said solution, said marking roll having bare portions and electrically non-conductive coated portions on its surface, said coated portions having sufficient thickness so that said bare portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said bare portions of the surface

of the metal marking roll to the metal surface of said roll, and then to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said bare portions.

6. The method of marking metal stock which comprises removing metal strip from an aqueous solution in a manner which permits a film of said solution to be retained on the strip, contacting one side of the strip with the periphery of a marking roll located above said solution, said roll having on its surface electrically conductive portions and electrically non-conductive raised portions, said raised portions having sufficient thickness so that said electrically conductive portions do not contact the strip, supplying current from a current source to the strip and passing the current from the strip as anode through the aqueous solution retained on said electrically conductive portions of the surface of the marking roll to the metal surface of said roll, and thence to the current source, said current being of such magnitude as to impose at least a light etch on the surface of the strip adjacent said electrically conductive portions.

7. A tank containing an aqueous solution, means for conveying a wet, flat continuous metal workpiece from said solution, a non-carrying metal marking roll positioned above said solution and in contact with one side of said workpiece as the wet workpiece emerges from the solution, said marking roll having bare portions and electrically non-conductive coated portions on its surface, a current source and means for supplying current to said workpiece so that the workpiece acts as anode in an electrolytic cell formed by the workpiece, the metal marking roll and the solution retained on the bare portions of the surface of said roll, a back-up roll adjacent said marking roll, and means for returning current to said current source.

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ROBERT K. MIHALEK, *Primary Examiner.*