July 20, 1948. H. W. TRENBATH 2,445,372

PROCESS OF COPPER COATING STAINLESS STEEL

Filed April 26, 1945

FIG. 1.

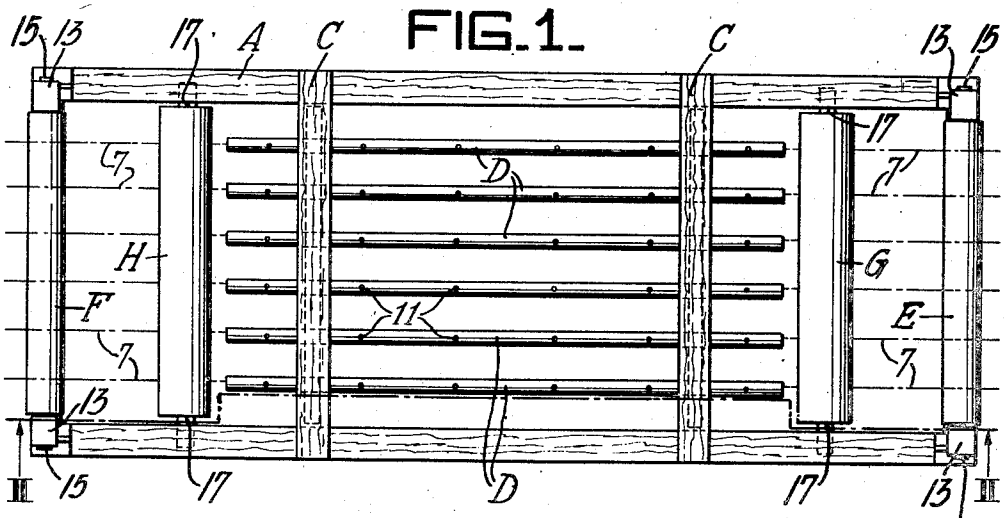


FIG. 2.

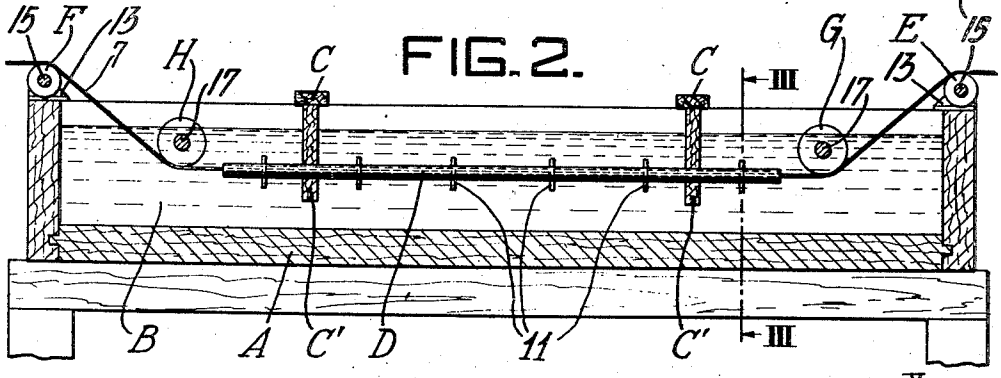


FIG. 3.

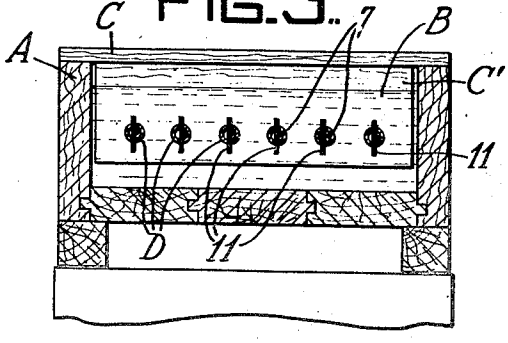


FIG. 4.

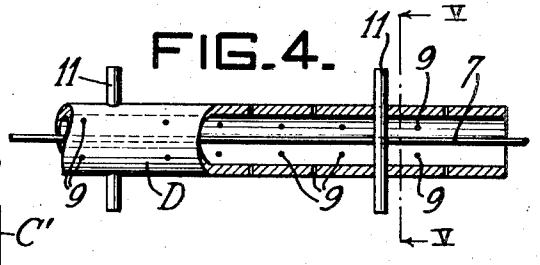
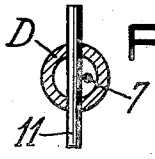


FIG. 5.



INVENTOR:
HERBERT W. TRENBATH,
BY:
John E. Jackson
his Attorney.

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PROCESS OF COPPER COATING STAINLESS STEEL

Herbert W. Trenbath, Shaker Heights, Ohio, assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey

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1 Claim. (Cl. 204—28)

In the production of stainless steel wire, it is common practice to coat the stainless steel stock with metallic copper, which serves as a wire-drawing lubricant for the stock passing through the dies, it being long recognized that metallic copper serves as a satisfactory wire drawing lubricant. Copper also is employed as a coating for stainless steel wire where it is desired to cover the wire with a rubber composition, the copper uniting with the sulphur contained in the rubber composition, thereby bonding the rubber to the wire.

In producing the coating of copper on the stock being drawn, it is usually applied by hot-dipping or by electroplating. It is desirable that the coating be applied continuously, but the procedures heretofore employed are open to various operating objections and difficulties, that make desirable a simplification of the coating operation. It is well known that copper will plate on mild or ordinary carbon steel by simply immersing the steel in an aqueous solution of a copper salt; but in the case of the stainless steels, whether such be straight chrome-steels or whether they be chrome-nickel steels, the surface of the steel is rendered passive by the presence of the chromium in the alloy, so that a straight displacement of copper from an aqueous copper salt solution does not take place; and consequently, in order to avoid the difficulties inherent to coating by hot-dipping including difficulties of obtaining uniformity of the coating, high temperatures required, and special precautions to be taken in protection of the bath by oxidation, it has been necessary to make the stainless steel stock a cathode in an electroplating tank using an aqueous solution of a copper salt as the electrolyte and electroplating the copper coating on the stainless steel stock by the use of an externally applied electroplating current.

It is rather difficult, however, to electroplate satisfactorily a continuously moving stock, and the operation is rather expensive, both from the standpoint of requirements for special equipment and from the standpoint of current costs.

In view of the objections that are inherent in prior practices, the present invention is designed to eliminate the need for such externally applied current while retaining the advantages of coating from an aqueous copper bath; and the present invention provides a close control on the character of the copper coating that is being formed.

Generally speaking, the present invention provides an improved process for copper plating stainless steel in a continuous manner by making the stainless steel stock the negative element of an electrolytic couple, using an acidified aqueous copper sulphate as electrolyte, and a dissimilar metal, for example, plain carbon steel, as the positive element of the couple. The stainless steel is either chrome steel or chrome-nickel steel (such as the so-called "18–8 stainless steel," for example).

In carrying out the process of the present invention, the alloy steel and the carbon steel are in contact, and are immersed in an acidified solution of copper sulphate and preferably maintained at a suitably elevated temperature, for example, approximately 170° F. The difference in potential between the two metals causes an electric current to flow from the carbon steel to the alloy steel, for example, a stainless steel wire or the like. The flow of the thus-produced current causes a copper ion in the copper sulphate solution to be neutralized at the surface of the alloy steel, to form a molecule of metallic copper.

The accompanying drawings illustrate one form of apparatus suitable for carrying out the process of the present invention, although it is desired to point out the fact that the illustrated embodiment is by way of example only, and is not intended to be limiting in character.

In the accompanying drawings,

Figure 1 is a plan view of a plating tank adapted for the practice of the present invention;

Figure 2 is a sectional elevation on the line II—II of Figure 1;

Figure 3 is a transverse sectional elevation taken along the line III—III of Figure 2;

Figure 4 is a fragmentary sectional elevation of one of the plating units employed in carrying out the present invention; and

Figure 5 is an enlarged cross-sectional elevation of one of the plating units of Figures 2 and 3, the view being taken on the line V—V of Figure 4, looking in the direction of the arrows, the view being an enlarged showing of the manner in which the wire being plated makes contact with the complementary contact members of the present invention.

Referring more particularly to the drawings, reference character A represents a suitable tank adapted to hold a solution B, which, in accordance with the specific aspects of the invention, preferably is an acidified aqueous solution of copper sulphate. Extending transversely across the top of the tank A and resting on the sides thereof, are frames C which comprise a relatively flat member which rests on the sides of the tank and

a depending portion C', which are provided with registering holes for the reception and retention of a plurality of tubes or pipes D.

Also extending across the top of the tank A, at or near the ends thereof, are guide rollers E and F, which guide the stock to be coated into and out of the tank, and a pair of sink rollers G and H, which are immersed in the solution B, and are mounted as shown in the opposite sides of the tank, guide the stock being coated through the pipes D. The rollers G and H obviously are composed of a material which is inert to the solution B, such as hard rubber, for example.

The equipment shown in the drawings is adapted to handle a multiplicity of strands of the stock being plated, which strands are indicated by the reference number 7. These strands are wire that has been partially drawn to gauge and is being coated with copper as to serve as lubricant in further passes through drawing dies; or the stock may be finished wire which is to be covered by a rubber composition.

In accordance with the specific and preferred aspects of the present invention, the strands 7 that are being coated are composed of stainless steel, for example that grade of stainless steel containing 18 per cent chromium and 8 per cent nickel, although the invention is not limited necessarily to the coating of such alloys, the invention being applicable generally to the coating of any steels containing chromium or chromium and nickel in alloying amounts, i. e., in purposely added amounts as distinguished from incidental traces. Where the strands 7 are composed of stainless steel, and the coating metal is to be copper, the pipes D may be composed of plain carbon steel, and the solution B is a solution of a water-soluble copper salt, for instance, copper sulphate, or copper nitrate, or copper acetate, the solution being preferably acidified by addition of the corresponding acid. The pipes D preferably are perforated, as indicated by holes 9, in order to permit full access of the solution into the interior of the pipes, and free circulation of the solution through the pipes. The pipes D also are provided with registering holes for the introduction and retention of pins 11, which also may be of plain carbon steel, and which are slightly staggered so that opposite surfaces of the strands 7 come into wiping engagement with the pins 11, and form therewith the electrolytic couple which is an important feature of the present invention.

As the strands 7 move through the pipes D, and contact with the pins 11 in wiping engagement therewith, the strands become coated with an adherent deposit of copper, the plain carbon steel of the pipes D and pins 11 dissolving as the coating proceeds, a molecule of copper being deposited on the strands 7 for each molecule of iron that enters the solution from the plain carbon steel.

The tank A may be composed of wood which has been treated to withstand corrosive action of the electrolyte B. Guide rollers E and F are mounted in brackets 13 by means of shaft members 15, the brackets 13 being secured suitably to the top of the tank. Such rolls E and F have shaft portions 17 mounted in suitable bearings formed in opposite sides of the tank, as indicated in Figure 1.

While the invention has been described in connection with its preferred specific embodiment, that is, coating stainless steel with copper by making the stainless steel one element of an electrolytic couple, employing mild, or plain carbon steel as the other element of the couple with copper sulphate as the electrolyte, in its broader aspects the invention provides a method of coating alloy steels containing chromium, or chromium and nickel, in alloying quantities, with a coating metal by immersing the steel to be coated in an aqueous solution of a water-soluble compound of the coating metal as electrolyte, and maintaining the immersed alloy steel in contact with a metal electropositive to the coating metal, thereby producing a galvanic electrolytic couple between the alloy steel and the electropositive metal, thereby producing a plating of the coating metal on the alloy steel.

Since, in the illustrated embodiment of the invention, the strands 7 are moving continuously through the tank A, it is necessary that the plating thereof be carried out rapidly. In order to assure the requisite rapidity of the coating, the electrolyte B may be heated as has been indicated above, by any suitable means, not shown. Where copper is being plated on stainless steel, an electrolyte temperature of approximately 170° F. is found to give good results. Also, instead of the perforated pipes D and inserted pins 11, any other contact bodies may be employed that may be convenient, so long as such bodies are composed of a suitable electropositive metal. Thus, in the embodiment of the invention herein specifically described and illustrated, there may be employed as contact bodies, dragging chains of plain carbon steel, or multiple contact sinkers of plain carbon steel, such bodies functioning as well as the illustrated perforated pipe and inserted pins.

In practice, the temperature of the bath is maintained, in any suitable manner, between 170° F. and 185° F. Any water-soluble copper salt may be employed, such as cupric sulphate, cupric acetate, cupric nitrate, and the like; or a mixture of copper salts may be employed, such as a composition approximating 78 per cent cupric sulphate, approximately 20 per cent cuprous chloride, and approximately 2 per cent of an addition agent such as a lignin composition ("goulac"), or other well-known addition agents. It will be understood that the aforementioned bath compositions are not critical nor even illustrative of the only operative copper coating baths, a bath composed simply of a solution of copper sulphate functioning substantially equally as well. The bath can be employed by keeping up the proper percentage of acidity until a Baumé gravity of 20° is reached. In practice, the following sizes of wire have been coated successfully by the process of the present invention, at the indicated maximum speeds, this data being given by way of illustrative examples of the present process:

- $\frac{5}{16}$ inch diameter wire (0.312 in.), 34 feet per minute
- 8-gauge (Washburn and Moen gauge), diameter 0.162 inch, 47 ft. per minute
- 13-gauge (Washburn and Moen gauge), diameter 0.0915 inch, 61 ft. per minute

It will be understood that the foregoing figures are examples only of the present process, and while obviously maximum speeds of operation that give uniform coatings are best from the standpoint of economic considerations, slower speeds than those indicated above have no detrimental effect on the quality of the coating.

In making up the coating bath, regardless of the salt that may be employed, the solution is made up at the start to a gravity of approximately five degrees Baumé. This figure changes

very slowly as no iron is taken from the stainless wire that is run through the bath. As has been indicated above, the solution can be used by keeping the proper percentage of acidity until a Baumé gravity of twenty degrees is reached.

I claim:

The process of electrochemically coating stainless steel wire with copper without externally applied electric current, which comprises moving the stainless steel wire through an aqueous solution of copper sulphate as electrolyte and maintaining the wire while immersed in said solution in contact with plain carbon steel bodies, the stainless steel wire and plain carbon steel bodies being in direct contact with each other at spaced apart points within said solution, thereby forming a galvanic couple between the stainless steel wire and the plain carbon steel bodies, said contact being maintained until said wire is coated with copper from the electrolyte.

HERBERT W. TRENBATH.

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