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[54] **CONDUCTOR ROLL**

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[52] **U.S. Cl.** ..... **191/1 A;** 204/25

[51] **Int. Cl.** **B01k 3/00**

[58] **Field of Search** ..... 191/1 A; 29/148.4 D, 597, 29/110, 123, 129; 204/279, 25

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[57] **ABSTRACT**

A conductor roll adapted for conducting electroplating current from a metal strip to an external means and including a hollow steel body. The roll is produced by having the external surface thereof covered with an electrically conductive hard-electroplated layer, and having the internal surface thereof covered with a layer of copper plated thereon. The roll further has a copper roll shaft including a copper flange which is shrinkage-fitted in the aforesaid copper layer of the roll body by using a heating and cooling technique, so that the aforesaid flange intimately contacts the plated copper layer.

5 Claims, 2 Drawing Figures

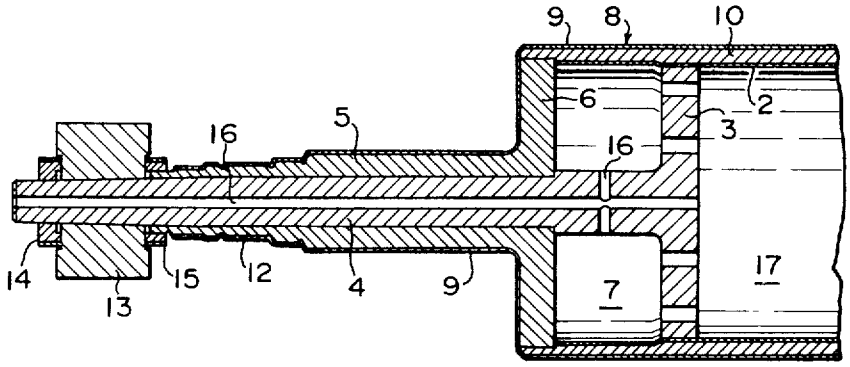


FIG. 1

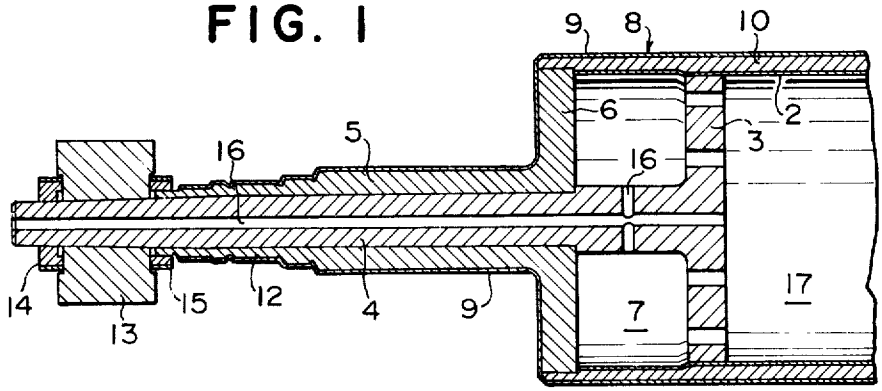
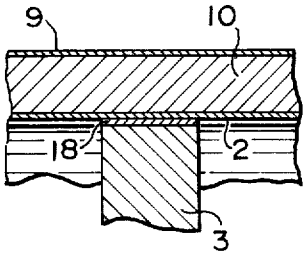


FIG. 2



CONDUCTOR ROLL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a conductor roll adapted for use in conducting electroplating current from a metal strip to an external means, in a continuous electroplating of a metal strip.

2. Description of the Prior Art

In the continuous electroplating of a metal strip, a conductor roll is maintained in contact with a metal strip and driven at a peripheral speed corresponding to the travelling speed of the metal strip. However, it is a common practice that an electric current of a low voltage and high amperage such as of 18 volts and 16,000 amperes, respectively, is introduced through a conductor roll for electroplating. For such an application, a solid pure copper roll having a high electric conductivity has long found its use. However, such a copper roll has suffered from shortcomings in that, due to the lower hardness of the pure copper, the surface of a roll is susceptible of damage and that the pure copper is costly.

Thus, for avoiding the aforesaid shortcomings in the conventional solid type roll, there has been proposed a Japanese Patent Publication No. 32130/70 published on Oct. 16, 1970 and issued to Hiroyuki Hatagi, et al., in which there was disclosed a roll of so called a dual construction consisting of an outer shell made of medium carbon steel adapted for preventing damage thereon and a pure copper core cylinder which is of good electric conductivity and fitted in the aforesaid shell. In this dual construction type cylindrical roll, the flange of a copper roll shaft is brazed to an inner copper roll. However, this meets only partial success in avoiding the aforesaid shortcomings and presents a problem that, upon assembly, there is likely to be caused looseness or clearance, which gives adverese effect on electric conductivity, between the steel outer roll and the copper inner roll, or distortion of the roll surfaces. This is because difficulties are encountered with accurate or intimate fitting or lining of the copper roll in the outer shell or because, despite different expansion coefficients of the two materials, the mating portions of the inner roll with the flange of the roll shaft is heated for brazing to a temperature of about 600°C.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a conductor roll which is provided with a hollow steel roll body having a roll surface of a high strength and an inner surface of a good electric conductivity.

It is a further object of the invention to provide a conductor roll which is simple in construction and easy in manufacture.

It is a still further object of the present invention to provide a conductor roll which may save the material to be used and hence is not expensive.

It has now been found that the foregoing and related objects can be readily attained in a conductor roll of the invention, comprising a hollow steel roll body having an outer surface covered with a chromium plated layer or a nickel-plated layer and an inner surface thereof covered with a copper layer electroplated thereon; a copper roll shaft including a flange shrinkage-fitted in said hollow body by using a heating and cooling technique in such manner that said flange contacts said plated copper layer, said flange being coupled to said shaft; and a sleeve, in which said roll shaft is fitted and which has a flange coupled to said roll body.

According to the present invention, a hollow roll body is coupled to a roll shaft, with the flange of the aforesaid roll shaft being shrinkage-fitted in the aforesaid hollow roll body by using heating and cooling technique. For this purpose, the hollow roll body is heated to 100°C, while the flange of the roll shaft is cooled to −50°C. Thereafter the roll and shaft are brought back to a temperature range close to room temperature. As a result of the new construction there is no possiblity of peeling or separation of the copper layer from the aforesaid hollow roll body, nor blisters on the copper layer. Particularly, according to the present invention, since the plated copper layer is formed intimately on the inner surface of the hollow roll body, there is no danger of the aforesaid defects, experienced with the conventional dual construction type cylindrical roll, such as clearance between the outer and inner roll cylinders. Thus the invention has the result that the electroplating current can be conducted in an improved manner from the metal strip via the copper layer to the roll shaft including the flange coupled to said shaft.

The above mentioned and other objects and features of the invention will become apparent from the following detailed description taken in conjunction with the drawings which indicate embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-sectional view showing part of the new conductor roll, taken along the axial line of the roll; and

FIG. 2 is a modified detail view.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a conductor roll of the invention, which comprises a cylindrical hollow steel roll body **10**. The roll body **10** has an inner surface which is copper-plated, thus providing a layer **2** of copper electroplated on said inner surface and thereby uniformly intimately bonded to all portions of said inner surface. With this layer **2**, a flange **3** of a copper roll shaft **4** is in contact. In other words, the flange **3** is fitted in the hollow roll body **10**, so that the hollow body **10** is electrically connected through copper layer **2** and flange **3** to the copper roll shaft **4**. A steel shaft sleeve **5** is provided on the roll shaft **4** and formed with a flange **6** which is coupled to the end portion of the hollow roll body **10**. As shown, with this embodiment of the invention, there is defined a chamber **7** between the flange **3** of the roll shaft **4** and the flange **6** of the sleeve **5**. However, this chamber should not be construed in a limitative sense, and hence the flange **6** may contact the other flange **3**. The hollow roll body **10** is fitted on the flange **3** of the roll shaft **4** by using a shrinkage-fitting technique by resorting to heating and cooling operations. For instance, the roll body **10** is heated to 100°C, while the roll shaft **4** is cooled to −50°C. Alternatively, the hollow roll body **10** may be welded to the flange **6** of the shaft sleeve **5**. Still alternatively, the shrinkage-fitting technique may be used for coupling the flange **6** to the hollow body **10**.

Hard electroplating, such as for instance, hard chromium plating or nickel plating may be applied to the outer surface **8** of the roll body **10** and that of the shaft sleeve **5**, including the outer surface of the flange **6**, so that a hard, metallic, electroplated layer **9** may protect the roll body **10** from damage.

The sleeve **5** is formed with a bearing portion **12** which rotatably supports the roll body **10** in cooperation with another bearing portion (not shown).

On the other hand, an electric conductor ring **13**, coupled with lock-nuts **14** and **15**, is affixed on the end portion of the roll shaft **4**, whereby electric current is introduced from the roll shaft **4** through a brush (not shown) in contact with the electric conductor ring **13** to external means. The roll shaft **4** is adapted to rotate with the shaft sleeve **5**. The roll shaft **4** may be welded to the sleeve **5**.

There is defined a cooling-water passage **16** through the roll shaft **4** along the axial line thereof, with the exits of passage **16** being open to a cavity **17** in body **10**, communicating with chamber **7** through apertues in piston **3**. It is needless to mention that the supply of cooling water through the aforesaid passage **16** may absorb joule heat generated in the roll body **10**. The right-hand portion of the conductor roll is not shown in the drawing, but its construction is identical to that of the left-hand portion which is shown. In addition, the drive means is not shown in the drawing, because it is well known to those skilled in the art.

Turning now to FIG. **2**, there is shown a small part of the conductor roll according to the present invention, which is somewhat different in construction from that shown in FIG. **1**. FIG. **2** illustrates the portion of roll body **10** coupled to flange **3** of the roll shaft **4**. As is clear from the drawing, there is applied a silver layer **18** between the copper layer **2** electroplated on the roll body **10** and the copper flange **3**. The silver layer **18** is formed on the edge surfaces of **3**. As a result, the contact of the flange **3** by electroplating the silver layer on this edge surface through the silver layer **18** with the roll body **10** having a plated copper layer thereon reduces contact-resistance therebetween, thereby improving electric conductivity thereof.

The conductor roll according to the present invention may readily be manufactured. More particularly, after the plated copper layer **2** has been applied on the inner surface of the hollow roll body **10**, the flange **3** of roll shaft **4** is shrinkage-fitted in the roll body **10** by using heating and cooling fitting technique. Then, the shaft sleeve **5** is fitted on the roll shaft **4** by introducing the sleeve from the end portion of the shaft onto the shaft. Thereafter the flange **6** thereof is rigidly coupled to the end portion of the hollow roll body **10**. Thereafter, the outer surface of hollow roll body **10** is machined for center-alignment. Upon completion of such operations, hard chromium plating **9** is applied to the outer surface of roll body **10** as well as to the surface of shaft sleeve **5**, at the same time.

As is apparent from the foregoing description, plated copper layer **2** is applied on the inner surface of steel roll **10**, while the flange **3** of copper roll shaft is shrinkage-fitted in roll body **10** by using a heating and cooling technique so that the flange **3** contacts the plated copper layer **2**. As a result, there is no possiblity of the plated copper layer being peeled from hollow roll body **10**. This plated copper layer **2** tightly adheres on the one hand to the roll body **10**, and on the other hand to the flange **3** of roll shaft **4**. This in turn ensures electric conductivity as high as that of the conventional solid type roll, while the material to be used therefor may be materially reduced. In addition to this, the conductor roll of the invention may avoid difficulties and defects in electric conductivity such as are experienced with conventional dual-construction type cylindrical rolls.

It will be understood that the above description is merely illustrative of preferred embodiments of the invention. Additional modifications and improvements utilizing the discoveries of the present invention can be readily anticipated by those skilled in the art from the present disclosure, and such modifications and improvements may fairly be presumed to be within the scope and purview of the invention as defined by the claims that follow.

What is claimed is:

1. A conductor roll for conducting electrical plating current, comprising:

a hollow steel roll body having an inner surface and an outer surface;

a hard metallic layer covering said outer surface; a copper layer plated on said inner surface;

a copper shaft having a copper flange integrally connected thereto, which flange includes a silver layer in contact with the copper layer of said roll body to mount the flange of the shaft in said hollow body with firm electric contact between said copper and silver layers and said copper flange; and

an electric conductor ring affixed to said shaft externally of said roll body.

2. In a conductor roll for conducting electroplating current:

a hollow steel roll body having an inner surface and an outer surface;

a hard metallic layer on said outer surface;

a layer of copper plated on said inner surface; and copper roll shaft means fitted into said layer of copper to intimately contact said layer.

3. In a roll according to claim **2**, a copper flange integrally connected to said shaft means and shrink-fitted to said layer of copper.

4. In the manufacture of a conductor roll for conducting dense electric currents:

making a hollow steel roll body with an inner surface and an outer surface, both cylindrically formed;

depositing a hard metallic layer on said outer surface;

electroplating a layer of copper on said inner surface; and fitting copper roll shaft means into said layer of copper to intimately contact said layer.

5. In manufacture according to claim **4**, shrink-fitting said layer of copper to said copper roll shaft means.

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