Jan. 15, 1963 W. J. MANSON 3,073,773

ELECTROLYTIC PLATING

Filed Dec. 5, 1957 3 Sheets-Sheet 1

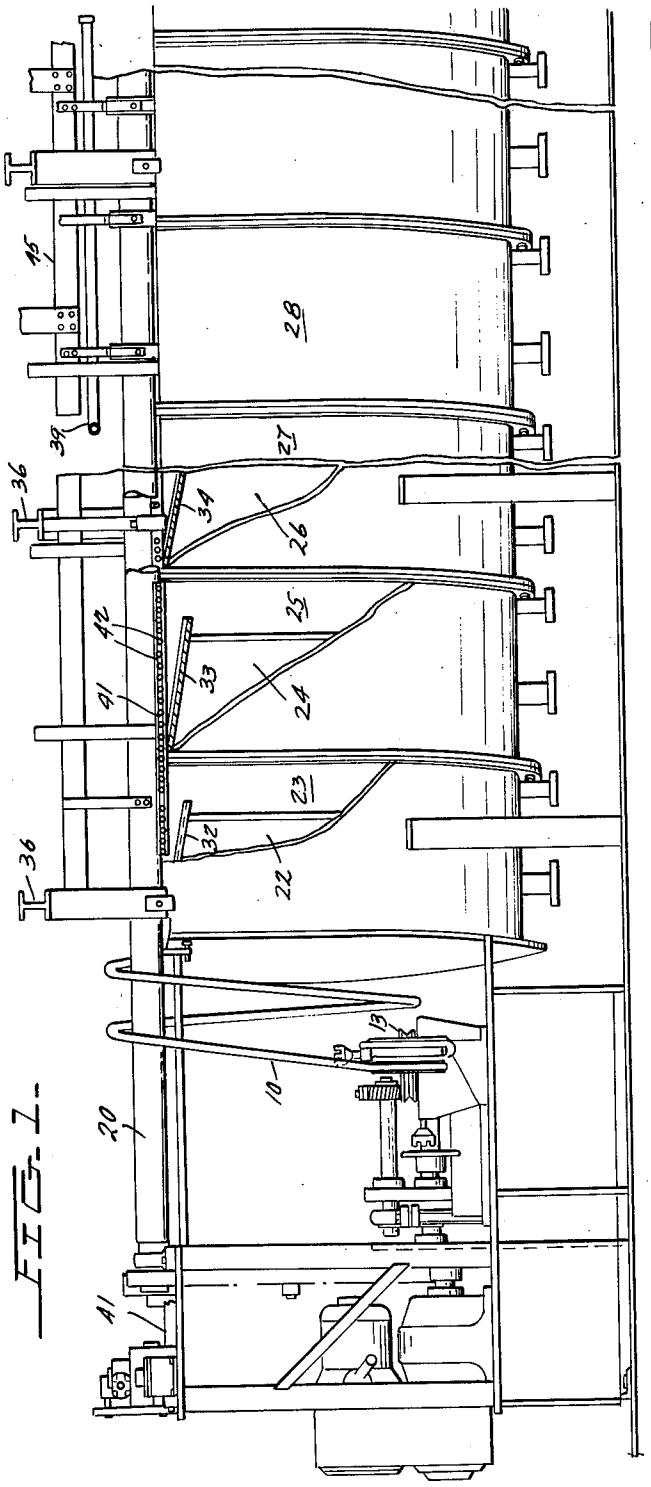


FIG. 1

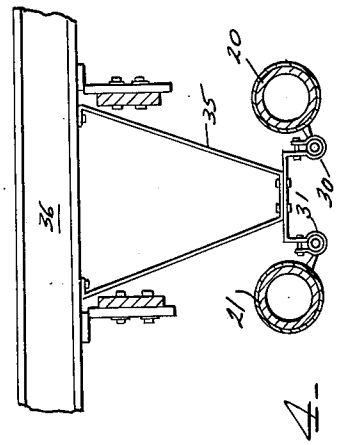


FIG. 4

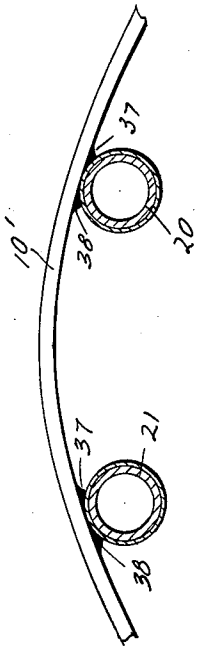


FIG. 7

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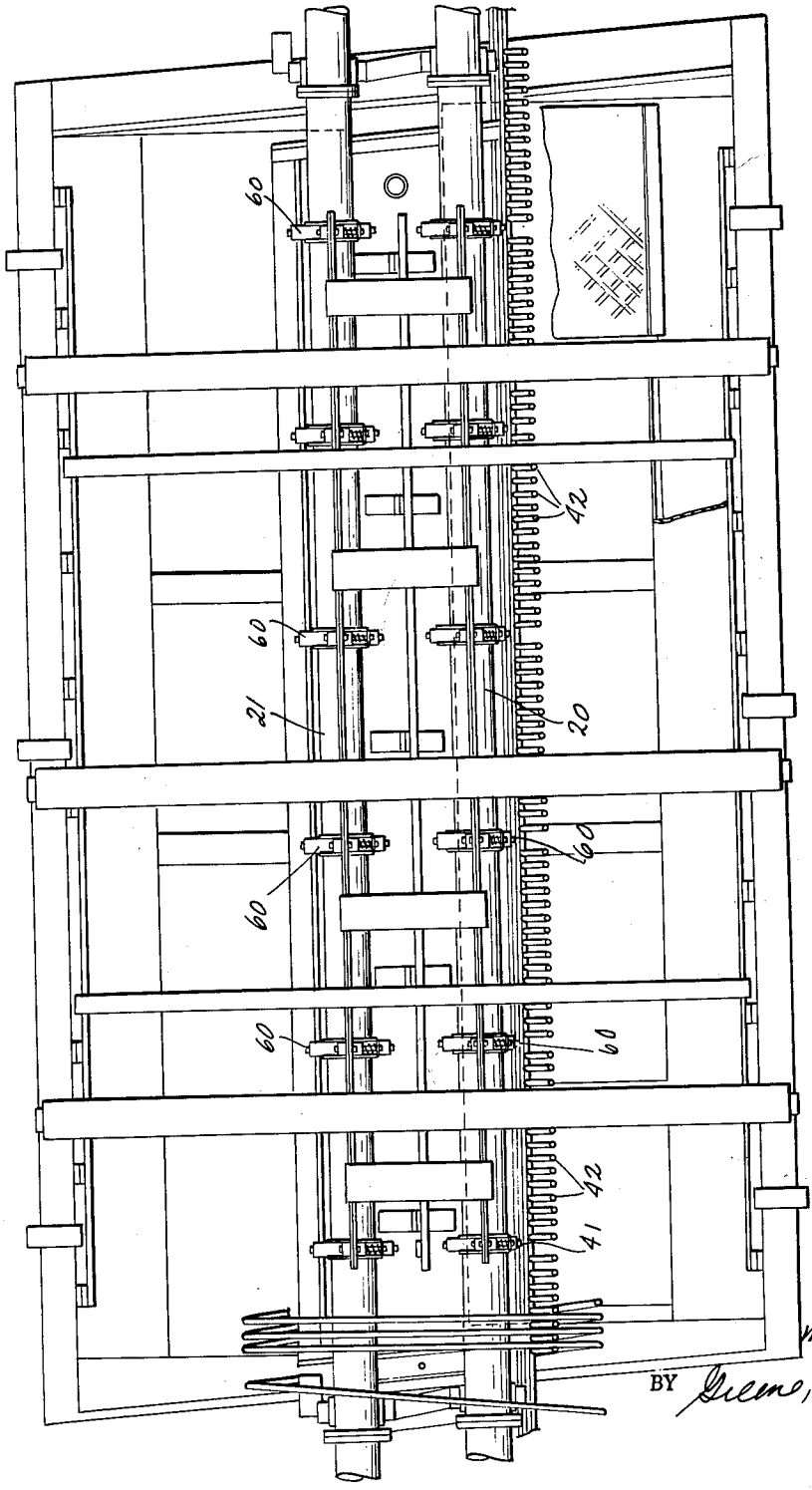


FIG. 2.

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FIG. 5.

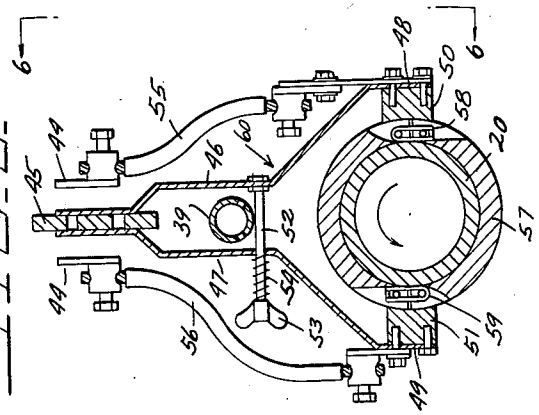


FIG. 6.

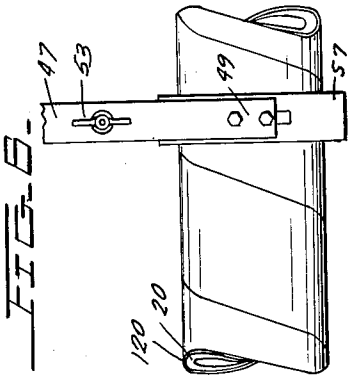
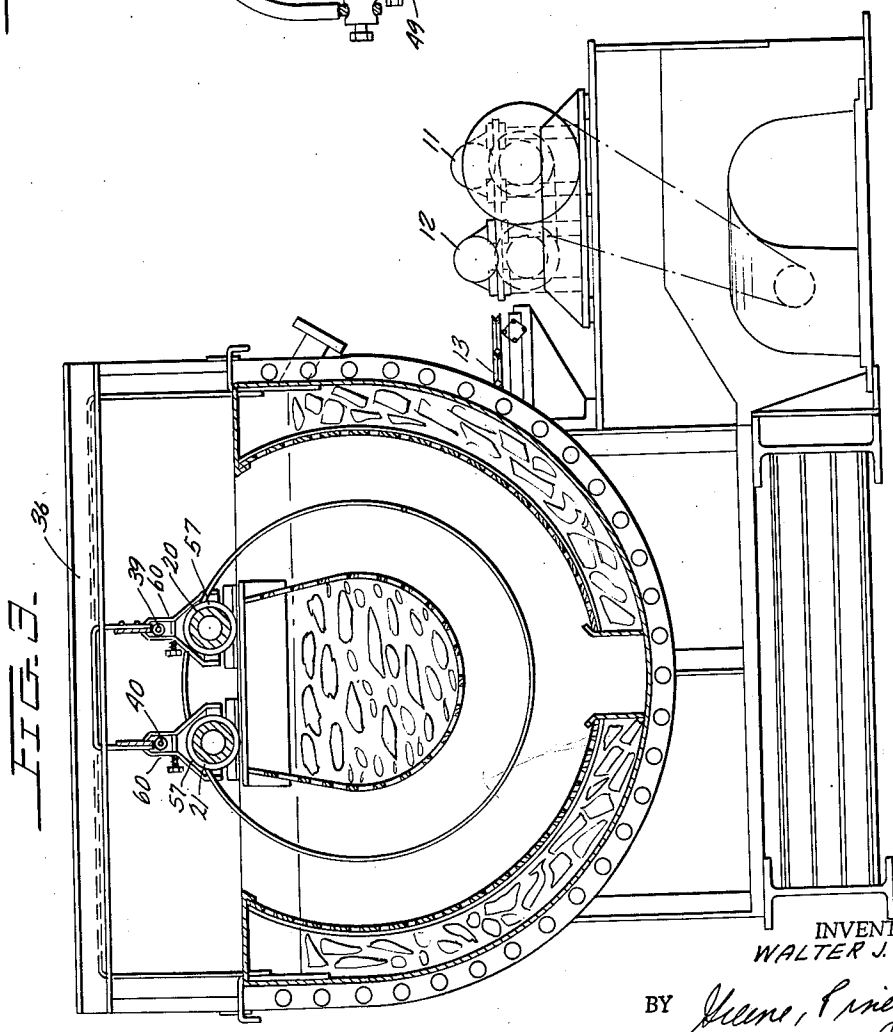


FIG. 3.



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United States Patent Office 3,073,773 Patented Jan. 15, 1963

3,073,773

ELECTROLYTIC PLATING

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Filed Dec. 5, 1957, Ser. No. 700,301
1 Claim. (Cl. 204—207)

This invention relates to an improved process and apparatus for continuously electroplating wire and more particularly it relates to an improved continuous process and apparatus for a composite copper steel conductivity wire having at least 20% of the conductivity of a pure copper wire of the same size.

The term wire will be understood to include any continuous essentially one dimensional material regardless of whether the cross sectional shape is round, flat, polygonal, or hollow.

The process and apparatus of this invention constitutes an improvement on the process and apparatus of U.S. Patent 2,680,710 according to the disclosure of which wire is continuously drawn, fed through a straightening device, then continuously curved to the form of a helix having a horizontal axis. While the helix is rotated and fed horizontally by continuously feeding more wire to the curving means the lower portions of a number of coils are submerged in one or more treating baths including an electroplating bath. This process produces a plated wire with such adherent layers of plated metal that large diameter wire may be employed as the starting material which can be drawn down to any size desired after plating.

One very desirable plated wire which it has not been possible to manufacture by the process and apparatus of said patent is a steel core, copper plated wire having 20 percent of the conductivity of pure copper called "20% conductivity wire." Thus the copper plating on such wire is of substantial thickness and the product may be called a composite wire since the copper portion is thick enough, per se, to become a wire. When it has been attemped to plate such high proportions of copper onto a steel base wire by the process of said prior patent the product had a distinctly rough surface containing enlarged globules or bumps of the copper and such wire was not capable of being drawn down to smaller size. To be commercially useful a composite copper steel wire must pass rigid tests. The copper must be firmly united to the core so that it does not separate therefrom upon twisting, bending or hammering and the copper portion must be non-porous.

Among the objects of this invention is to provide an improved process and apparatus capable of copper plating ferrous metal and similar basis metal wire with copper of any thickness desired.

One phase of this invention is based on the discovery that for plating thick layers of copper onto wire a large amount of current must be fed to the wire and the helix must be stabilized while made the cathode during its rotation through the electroplating bath and can not be permitted to swing laterally toward and away from the anodes or to move even a small distance away from its electrode contact.

Another phase of the invention is based on the discovery that nuclei form deformities in the copper plating originate when the electrode contacts for the wire do not make good and uniformly constant contact with the wire.

Among other objects of this invention is to provide an improved method and apparatus for continuously feeding electroplating or electrolytic treating current to a continuously rotating helical wire coil and especially for

feeding relatively large amounts of current to each one of a continuous series of helical wire coils.

With non-continuous articles no problem of contacts exists since the article to be plated may be tightly gripped by a contact means and suspended in the electroplating solution. However, in any process where wire is continuously electroplated the necessary electroplating current must be supplied to the wire either through sliding or rolling electrodes. Where sliding or rolling contacts or electrodes are employed the amount of current supplied depends on the constancy and on the degree or quality of contact between the wire and the electrode and it is rarely possible to obtain uniformity of the electrolytic current in the wire. When the wire, in the form of a helix, is fed in and out of a copper plating bath a plurality of times the film of bath liquid carried by the wire sometimes serves to separate a sliding electrode from the wire thereby producing a miniature electrolytic cell between the wire and the contact electrode. Such miniature cells produce undesirable effects such as a rough copper deposit on the electrode, a small depression in the wire or an undesirable growth on the wire. The effect is especially undesirable where the electrode contact is caused to bounce due to previously formed small imperfections in the wire or due to some instability of the wire helix such as a swinging motion; in such cases the surface tension of the bath liquid prevents the latter from completely breaking away from the elements and instead the contact and wire are connected by a narrow tube of the copper electrolyte. The roughness of the deposit caused by this effect is cumulative so that it is impossible to continuously plate very great thicknesses of copper onto the basis wire and obtain a drawable, uniform product.

Among other objects of the present invention is to provide an improved roller type of contact between a travelling helix of wire and a source of electricity.

The objects of the invention are attained by supporting the wire helix upon two or more internally positioned steel (or similar metal) supporting rollers, and feeding the electroplating current to the individual coils of the wire through one or more of the supporting rollers. The steel supporting, transporting and current-conducting roller which may be, for example, about 3 or more inches in diameter is capable of conducting sufficient electrical current to the wire. When the roller is corrodable by the electrolyte solutions a very satisfactory arrangement is to wrap the roller with conducting metal tape which may be stainless steel or any metal of good to mediocre conductivity which is not readily attacked by the electrolyte and does not undesirably contaminate the electrolyte. The weight of the wire together with the tension as a result of the support of the weight of the wire helix between two or more rollers provides for stability of the helix and also provides for stable and uniform contact between the wire and the supporting roller electrodes.

Since the supporting roller is of smaller curvature than the helix of wire there is still a tendency for copper to plate onto the plating roller or onto the covering tape of such a roller. Where this effect interferes with the plating, it is overcome by gradually changing the position of the coils on the supporting roller and by continuously removing deposits from the supporting roller by spraying the latter with bath solution. The position of the coils of the wire helix on the supporting roller or rollers is changed by slowly oscillating the helix axially with respect to the axis of the roller or rollers. This may be done by moving the roller while holding the helix in position, by reversing this process or by moving both helix and rollers axially in opposite directions.

In the drawing:

FIG. 1 is a side view partly cut away of an apparatus embodying the invention.

FIG. 2 is a top plan view of the plating section of the apparatus of FIG. 1.

FIG. 3 is a cross sectional view of the apparatus taken across the plating section and looking toward the end into which the wire helix first enters the apparatus.

FIG. 4 is a detail view of a portion of the pretreatment section of the apparatus.

FIG. 5 is a detail view of one of the electrical brushes for feeding electrical current to the roller.

FIG. 6 is a detail view of a supporting roller having a conducting tape wrapped thereon.

FIG. 7 is an enlarged detail view showing the contact of the wire helix with the supporting rollers.

The wire which is to be plated may be formed into a helix in any desired manner but a very satisfactory apparatus for forming the helix is similar to that of U.S. Patent No. 2,680,710. The wire 10 is drawn axially off of a coil (not shown) by the capstan device. Between the capstan device and the coil the wire is drawn through a die which has an opening somewhat smaller than the cross section of the wire so as to draw the wire and thereby remove scale, kinks and also the twist in the wire. Thence, the wire 10 passes to pushing and forwarding roller pairs, which push the wire through a horizontal set of straightener roller 13 and a vertical set (not shown) then over the curving device (see FIGS. 1 and 2). This much of the process and apparatus is shown in said prior patent.

From the curving device the wire passes upwardly in helical form to the pair of longitudinal horizontal supporting rollers 20 and 21. These supporting rollers are themselves supported in half bearings positioned at spaced points along the frame of the apparatus and the supporting rollers are rotated at the same peripheral speed through an adjustable speed change device. Prior to being plated the suspended portion of the wire helix 10' dips into a series of pretreatment baths 22, 23, 24, 25, 26, 27. The number and composition of such baths will depend on the wire being treated and on the nature of the plating or final treating solution. In a typical bath sequence, bath 22 is an anode cleaning bath, 23 a water rinse, bath 24 contains detergent for cleaning, bath 25 is another water rinse, bath 26 contains dilute sulfuric acid, bath 27 is another water rinse. The baths which follow the bath 27 are for copper plating.

Wetting Supporting Rollers Over Pretreatment Baths

The particular electrode contact structures for feeding current to the wire which are described below supply exceptionally uniform and high current to the wire being plated so that very thick copper plating may be applied to the wire. The high current applied produced an additional problem not present in the previous apparatus. In the manufacture of conductivity wire with a steel core it is common to plate 20% or more of copper onto the steel basis wire. This wire is drawn down to size and wound on what is known in the industry as 600 lb. reels. Occasionally where such reels were being produced the wire would break during drawing before a 600 lb. reel had been filled. Since there is no demand for fractional portions of such reels, the breakage caused a loss even though the wire appeared to be perfect on both sides of the break.

Examination of the wire at the breakage point, by the microscope, etc., showed that there was a portion of martensite at the breakage point. Close observation of the wire during the treating and plating process disclosed that occasionally arcing occurred between the wire to one of supporting rollers in the non-plating sections. The arcing apparently produced melting which is followed by rapid cooling and it is the rapid cooling of the molten or high temperature spots which produces the martensite. It has now been found that this arcing can be prevented by keeping the rollers wet. However, if the rollers are wetted with the treating solutions the solutions will soon carry over and contaminate the aqueous rinsing baths whereas if water is fed to the rollers the treating solutions will be diluted. The arcing is actually prevented by spraying the rollers 20 and 21 with water from tubes 30 or 31 (see FIG. 4) and catching the water in drip pans 32, 33, 34, etc., which guide the water dripping from the rollers 20 and 21 into the next succeeding water rinse bath 23, 25 and 27, respectively. The spray tubes 30, 31 contain a plurality of orifices along their length directed toward rollers 20 and 21, respectively. The tubes are held at spaced points by the supporting brackets 35 suspended from I-beams 36 of the supporting frame for the machine.

Supporting Rollers Over Plating Sections

With respect to the supporting rollers over the plating baths a somewhat different problem results from the feed of the electrolytic current therethrough. As shown in FIG. 7 the wire 10 does not make a perfect contact with rollers 20, 21 and the combined result of this imperfect contact and the surface tension of the bath liquid is that the regions 37 and 38 and 92 contain the copper plating solution between two metal electrodes with a difference in electrical potential. Deposition therefore takes place on the rollers 20 and 21. In order to nullify this effect, the rollers 20 and 21 are sprayed with plating solution by means of pipe spray devices 39, 40 which extend the length of the plating section and which may be held between the electrode structures 60 as illustrated in FIG. 3. These pipes comprise openings which extend toward rollers 20 and 21 but do not include any openings which spray onto the electrode structures 60. The solution dissolves the plated metal from the roller and returns it to the bath.

The pressure of the wire 10 on the supporting rollers 20, 21 possibly with the aid of the corrosive action of the electrolytic bath or baths tends to wear grooves into these supporting rollers or the conducting tape covering said rollers. Also the copper deposited under the wire where it is protected from removal by the spray nozzles 93, 94, etc., tends to cause the wire to become rough after a time. These undesirable effects are overcome by slowly oscillating the helix axially relative to the supporting rollers. The oscillation is slow so as not to distort the helix or scrape the wire. An oscillation moving at the rate of about 1 inch per minute is very satisfactory, although the rate can be of the order of the diameter of the wire per minute up to about 10 times the diameter of the wire per minute. The distance of oscillation may be approximately equal to the pitch of the helical coils.

The guide rod 41 contains a plurality of guide pins 42, one pin to fit between each two adjacent coils of the helix 10'. The guide rod 41 extends to the left hand end of the machine as shown in FIG. 1 and is connected to a mechanism 43 for oscillating the same. This guide rod 41 is longitudinally oscillated at a slow rate of speed to slowly change the position of the coils on the rollers 20—21 while the latter are retained in the same axial position. It is obvious, however, that the supporting rollers 20, 21 may be slowly oscillated to produce the same effect.

The Brush Contact Electrodes

The electric current is fed to one or preferably both of the supporting rollers 20, 21 or to a conducting metal tape 120 (see FIG. 6) on said supporting rollers by a plurality of brush contact electrodes shown in detail in FIG. 5. At least one bus bar 44 extends lengthwise over that portion of the apparatus which includes baths that are to be electrolyzed. Extending down from the frame 36 is a support bar 45 along which are attached pairs of arms 46, 47 which may be of metal having some springiness. These arms 46, 47 diverge at the lower portions

48, 49 so as to straddle the roller 20 (or 21) at its horizontal diameter. Attached to the ends 48, 49 are carbon brushes 50, 51. The tension between the ends 48, 49 of arms 46, 47 can be adjusted by the wing nut 53 on bolt 52, the nut 53 compressing spring 54. The arms 46, 47 may be attached directly to a bus bar and may then be of sufficient size and of conducting material so as to transmit the power from bus bar to brushes 50, 51 but the separate support 45 with conductor cable connections 55, 56 between the bus bar 44 and the brushes 48, 49, as shown in FIG. 5, are more satisfactory.

In the electroplating section shown in FIG. 5 provision is made for electroplating approximately 80 turns of the helix simultaneously and 12 such brush contact electrodes 60 are provided, 6 on each supporting roller 20 or 21. As a minimum to obtain 15% conductivity wire at least 50 turns in the electroplating bath are required. Relatively large amounts of current may be fed through said brush contacts 50, 51; for example, it is common to feed 200 amps. at the voltage required through each of said brushes 50 or 51.

The area of slippage, between the brushes 50, 51 and the conducting portions of the rollers 20 or 21 or the tape 120 on such rollers is kept free from bath liquid by connecting the conducting portions of the rollers 20, 21 to the brushes 50, 51 through collar devices 57. These collars 57 are split ring type collars having adjustable connections 58, 59 which can be tightened about the rollers. Whereas the roller 20 or 21 is continuously sprayed with the bath solution, from perforated tube 39, no spray is directed against the collars 57 and the liquid on the roller 20 or 21 does not travel up to the periphery of collars 57. As stated previously the guide bar 41 is slowly oscillated back and forth in the direction shown by the double pointed arrow at the left end of bar 41 in FIG. 2 for a distance of about an inch or less so that the wire helix 10' resting on rollers 20, 21 does not wear grooves in the latter and so that the spray solution from perforated pipe or tube 39 reaches all parts of the rollers 20, 21 to remove metal from the electrolyte solution which may be deposited on rollers 20, 21. The claim of this case has been restricted to the means for directing the water applied to the rollers into water rinse baths, other features

of application relating to the way in which electrical current is supplied to the wire are disclosed and claimed in applicant's copending continuation-in-part application, Serial No. 775,210, filed November 20, 1958.

The features and principles underlying the invention described above in connection with specific exemplifications will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claim shall not be limited to any specific feature or details thereof.

I claim:

In a device for continuously electroplating wire formed into the shape of a horizontal helix and supported upon at least one horizontal metal supporting roller so that the lower portion of the coils of the helix is surrounded by a series of vessels adapted to contain liquid treating agents, said series comprising a plurality of vessels juxtapositioned with respect to each other, electrode structures within at least one of said vessels, towards the end of said series a source of electric current for electrolyzing the bath held in the vessel containing said electrodes, alternate ones of said juxtapositioned series of vessels before the electroplating bath being of shorter extent and being adapted to contain water rinse, water spray devices adjacent that portion of the supporting roller above substantially all of said vessels except said electrode containing vessel, and trough means beneath the supporting roller adapted to conduct the water dripping from said sprayed rollers to the alternate shorter water rinse baths.

References Cited in the file of this patent

UNITED STATES PATENTS

901,399	Van Winkle et al.	Oct. 20, 1908
1,058,048	Gibbs	Apr. 8, 1913
1,515,092	Cowper-Coles	Nov. 11, 1924
1,601,642	Parker	Sept. 28, 1926
2,495,695	Camin et al.	Jan. 31, 1950
2,708,445	Mason et al.	May 17, 1955
2,748,784	Kenmore et al.	June 5, 1956

FOREIGN PATENTS

551,103	Great Britain	Feb. 8, 1943
1,121,057	France	Apr. 30, 1956