PROCESS AND APPARATUS FOR MAKING CHROMIUM COATED PAPERMAKING WIRES

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ABSTRACT OF THE DISCLOSURE

Rollers support a woven Fourdrinier wire as it progresses through a plating tank, which contains a chromium ion electrolyte continuously circulating from a reservoir, and a pair of positively charged anodes. A pair of rollers on opposite sides of the tank are negatively charged and transmit that charge to the wire. Jets of electrolyte are sprayed on the wire and rollers. The electrolyte conditions the wire to receive the chromium before the wire passes between the anodes, and shielding or straightening prevents excess deposition on the wire's edges.

The present invention resides in a process for continuously electrolytically depositing a chromium coating on a papermaking wire whereby a papermaking wire is given a negative potential and moved through a chromium ion containing electrolyte adjacent to a positively charged anode, and said papermaking wire is thoroughly washed after it emerges from said electrolyte. The present invention also resides in an apparatus for continuously electrodepositing a chromium coating on a papermaking wire wherein a papermaking wire is movable supported on a plurality of rolls, at least one of which is driven, two of which are used to guide the wire through a tank containing an electrolyte and a positively charged anode, and another two of which rolls are mounted above either end of the tank and are charged to impart a negative potential to said papermaking wire relative to said anode. The present invention relates to a process and apparatus for making the novel chromium plated papermaking wire which is the subject of our copending application, Ser. No. 304,869, now Patent No. 3,177,113. A papermaking wire is an endless formable belt, usually made of woven wire strands, although perforated sheets have been used. Woven papermaking wires are made from metallic warp and weft strands, such as Phosphor bronze or brass strands, and these are most commonly woven together in a twill or semi-twll weave although other weaves are also used. The wires thus made are used on a variety of different types of papermaking machines to form the initial web of paper by depositing a suspension of paper fibers on a papermaking wire so that the fluid drains through the interstices of the wire, leaving the matted fiber supported on the wire. The length, width, mesh and strand size of a papermaking wire depends, of course, upon the machine it is to be used on, the papermaking process used and the product to be made. Papermaking wires may be as much as 180 feet long and 350 inches in width. A mesh count of 75 seems to be very common, but the mesh may exceed 100. The size of the strands used generally varies between 0.013 and 0.005 inch in diameter.

In the past papermaking wires have been made with metal coated strands, but the strands were coated before weaving and they were not coated with chromium. The use of metal coated strands has been successful when softer metals, such as nickel or tin, are used for plating, but chromium has been found to be too stiff to withstand the stress encountered in the weaving operation. After the wire is woven, it is made into an endless belt by joining the ends in a seam. However, where coated wires were used to make the wire, the coating is interrupted by the seam, creating a highly vulnerable area for corrosion so that a variety of special remedies have been devised for protecting the seams. These problems have all been solved by the process and apparatus of the present invention which permits chromium plating of an endless papermaking wire after the wire has been woven and a seam made. Past efforts to chromium plate papermaking wires were generally failures for several reasons. Due to the large size of the papermaking wires and the necessary uniformity of coating required for papermaking wires, a process and apparatus for their continuous plating is needed, and none was available prior to the present invention. Also new processes and apparatus were needed to effectively utilize the large volume of electrolyte needed for an operation of the magnitude and precision required in the plating of papermaking wires. Moreover, a process for continuous plating an endless wire has generally been held to be infeasible because of the necessity to overplate the portion of the wire initially inserted in the plating solution. It was generally believed that such an overplate would not adhere to the first layer of plated chromium. Also, previous efforts to plate papermaking wires in the laboratory frequently resulted in holes being burned in the wire, a plating which is too rough for use in the papermaking wire, uneven plating vulnerable to premature fatigue failures, etching of the core strands, and a plating which was frequently discolored. Accordingly, the primary object of the present invention is to provide a process and apparatus capable of successfully making a chromium coated papermaking wire. Another object of the present invention is to provide a commercially feasible process and apparatus for making chromium coated papermaking wires. Another object of the present invention is to provide a process and apparatus for electroplating papermaking wires with chromium whereby a smooth, uniform chromium coating may be deposited without discoloration of the coating. It is another object of the present invention to provide a process and apparatus for continuously electroplating an endless papermaking wire with chromium whereby a successful overplating is achieved. It is another object of the present invention to provide a process and apparatus for electroplating a papermaking wire, which process and apparatus will not cause a burning of the wire. It is another object of the present invention to provide a process and apparatus for electroplating a papermaking wire with chromium, which process and apparatus permits precise control of the weight of deposition over the entire surface of the wire. It is another object of the present invention to provide a process and apparatus for electroplating papermaking wire with chromium that will achieve a secure bond of the chromium to the core strand without the need for an intermediate coating. It is another object of the present invention to provide a process and apparatus for electroplating a papermaking wire with chromium, which process and apparatus permit precise control of the quality of the plating. The foregoing objects will appear in the description to follow, along with other objects and advantages which may be more clearly set forth in the context of the description. In the description, reference is made to the accompanying drawings which form a part hereof and in which there is shown by way of illustration specific embodiments in which this invention may be practiced.
These embodiments will be described in sufficient detail to enable those skilled in the art to practice this invention, but it is to be understood that other embodiments of the invention may be used and that structural changes may be made in the embodiment described without departing from the scope of the invention. Consequently, the following detailed description is not to be taken in a limiting sense; instead, the scope of the present invention is best defined by the appended claims.

In the drawings:

FIG. 1 is a view in perspective of apparatus embodying the present invention,

FIG. 2 is a side elevation of a portion of the apparatus shown in FIG. 1, with portions broken away to expose certain internal components,

FIG. 3 is a top view in section of the apparatus embodying the present invention taken along the line 3−3 in FIG. 2,

FIG. 4 is a schematic diagram of the electrical system in the embodiment shown,

FIG. 5 is a view in section of a portion of the apparatus taken along lines 5−5 in FIG. 2 and showing current flow in the electrolyte,

FIG. 6 is the same view as FIG. 5 without thieving rods and sleeves on the ends of the anodes, and

FIG. 7 is the same view as FIG. 5 with the addition of masks extending from between the anodes against the lateral edges of the wire.

FIG. 1 shows an embodiment of the present invention in perspective, wherein an endless papermaking wire 1 to be plated with chromium is mounted about a wire supporting and drive mechanism having a plurality of wire support rolls 2, one or more of which may be driven by conventional controlled speed, drive motor and link means 3 to move the wire 1 about the supporting mechanism in the direction of the arrow shown in the drawing. Two of the rolls shown are conductor rolls 4 and 5 which are preferably copper surfaced and are adapted for connection to a controllable unidirectional current source 40, as will be explained in connection with FIG. 4. The remaining two rolls are inert rolls 7 and 8. The lower inert roll 7 is made of plastic and the upper inert roll 8 is of chromium plated steel. The inert rolls 7 and 8 are used to position and guide a portion 9 of the wire 1 which is being electroplated. A soft rubber contact roll 10 bears against the wire 1 as it passes over the rear conductor roll 4 to aid in achieving a good electrical contact between the wire 1 and the conductor roll 4.

The wire support and drive mechanism is mounted on a table 19 supported on legs 12 and on a frame structure on the front end of the table 11. The frame structure has four vertical posts 13 insulated from ground which, like the legs 12, stand on a floor 14. The posts 13 are joined intermediate their ends by horizontal end beams 15 and side beams 16. A short section of beam is butt welded to the top of each post 13 to extend horizontally inwardly forming brackets 17, from which are suspended bearings 18 mounting the conductor rolls 4 and 5. On top of the brackets 17 are mounted stringers 19 connecting the posts 13 and supporting a track 20 which extends through, and beyond the ends of the frame structure. Projecting from the front sides of the front posts 13 are horizontal structural pieces forming shelves 21 to support bearings 22 which mount the driven supporting roll 2, and the front ends of the shelves 21 are supported on struts 23. The inert rolls 7 and 8 are mounted in bearings 24 secured to the horizontal pieces of the front stringers 19. These stringers 19 mount one support roll 2, and the remaining support rolls 2 rotate in bearings 26 mounted on the table 11.

The plating apparatus is centered about an open top platting tank 27, which rests on blocks on the floor 14, and which is constructed to be long enough to receive the widest wire 1 to be coated on the apparatus. In the embodiment illustrated, the tank 27 is twelve feet long, and has a capacity of about 160 gallons within its end walls 28, back wall 29, and front wall 30. In front of the front wall 30 and extending the full length of the tank 27 is an overflow chamber 31 which is a key component in a circulation system for the electrolyte 33. The overflow chamber 31 communicates with the tank 27 through a row of overflow holes 32 through the front wall 30 at the desired fluid level of an electrolyte 35 in the tank 27 although simply lowering the top of the front wall 30 to the desired electrolyte level would serve as well as overflow holes 32. Preferably, the top of the overflow chamber 31 is closed to prevent the escape of vapor and fumes.

The electrolyte circulation system is completed by connecting the overflow chamber 31 through a return conduit 34 to an electrolyte reservoir 35. An input conduit 36 conducts electrolyte 33 from the reservoir 35 up through a pumping means 37 to a distribution pipe 38 extending above and across the back of the tank 27 and having outlets 39 spaced along it to introduce a flow of electrolyte 33 into the back of the tank 27 along the entire length of the tank 27. The pumping means 37 in the embodiment shown pumps about twenty gallons of electrolyte 33 per minute. The reservoir 35 contains coils (not shown) through which a heated, or cooled fluid may be circulated, as needed require, to maintain the electrolyte 33 at a predetermined desired temperature. That is a common heat control means and hence requires no further description here.

The electrolyte 33 used here is a conventional bath, consisting of an aqueous solution of chromic acid with a sulphate catalyst. Thirty-three ounces of chromic acid per gallon with one part sulphuric acid per hundred parts chromic acid is generally used. After the plating process has begun, trivalent chromium is formed in the electrolyte 33 in the amount of about two- to seven-tenths ounces per gallon. Of course, other chromium ion electrolytes may also be used.

Turning now to the electrical system, which is best illustrated in FIG. 4, the importance of maintaining the various components of the apparatus electrically isolated one from another should be noted. The tank 27 must be completely electrically isolated from the electrical system and ground to prevent the formation of spurious and undesired electrical paths. The support rolls 2 are maintained at uniform potential by virtue of their separate mountings and the conduction of the endless papermaking wire 1 supported on them.

A controllable unidirectional current source 40 provides current for the electrical system and is illustrated by a box in FIG. 4 to indicate that the nature of the source 40 used depends upon the current requirements of the specific installation as well as the equipment and commercial or other power supply available. The negative pole 41 of the source 40 is connected to brushes 42 that ride on the surface of the conductor rolls 4 and 5 to impart a negative potential to those rolls 4 and 5 and thence to the wire 1. The negative pole 41 is also connected to thieving rods 43, which are metal rods about one-eighth inch in diameter and positioned about a quarter of an inch from the edges of the wire portion 9 being plated to prevent excessive deposition of chromium on the selavage of the wire 1.

The positive poles 44 and 45 of the source are connected through independent controls 46 and 47, represented in the drawing by variable resistors, to upper and lower anodes 48 and 49, respectively. The anodes 48 and 49 are made of lead and their length should be equal to the width of the widest wire 1 to be coated with the apparatus. In the embodiment shown, the anodes 48 and 49 are twelve feet long and nine inches wide. Both anodes 48 and 49 are perforated to increase their surface areas to achieve maximum utilization of the anode, and to provide paths through which hydrogen generated by the electrolytic action may escape. Lead strips 50 are mounted on edge along the front and back edges of the upper
anode 48 to project above the electrolyte 33 level, and along the top of the strips 50, above the electrolyte 33, are copper bosses 51 which extend above and beyond the end walls 28 of the tank 27 to be electrically connected to the current source 40 as described above. Copper braces 52 join the bosses 51 at intervals along their length and hooks 53 extend upward from the braces for use in removing the upper anode 48. To support the upper anode 48 in the tank 27, the copper bosses 51 are mounted through openings in vertical standards 54 that rest on the end beams 15 of the frame structure. The standards 54 may be made of any inert material and in the embodiment shown rigid three-quarter inch thick plastic panels are used. The anodes 48 and 49 are mounted at an angle from the horizontal to permit the wire 1 to leave the electrolyte immediately after it is plated, and to facilitate the escape of hydrogen gas.

As the wire 1 enters the electrolyte 33 at the back of the tank 27, it is maintained electrolytically remote from the anodes 48 and 49 for a time to condition the wire preparatory to plating. This is accomplished by means of an inert shield 55 extending across the tank 27 behind the wire 1 to shield the outside of the wire, and by the lower inert roll 7, which is only partially immersed in the electrolyte and emerges about a quarter of an inch above the drum 13 to shield the wire 1. As is well known, however, chromium ion electrolytic baths have a comparatively short throwing power, and, therefore, the requisite electrolytic remoteness of the wire 1 as it enters the electrolyte 33 could be achieved by simple physical remoteness, however effected.

The anodes 48 and 49, with the wire portion 9 between them is illustrated in section in FIGS. 5, 6 and 7. FIG. 5 shows perforated anodes with sleeves 56 of plastic or other inert material over a portion of their ends extending beyond the lateral edges of the wire portion 9 to shorten the effective length of the anodes to approximately equal the width of the wire portion 9. Spaced from the edges of the wire portion 9, in FIG. 5, the thieving rods 43 may be seen in section. Broken lines extending between the anodes 48 and 49 and the wire portion 9 represent ion or current flow in the electrolyte 33, and it will be noted that the current flow tends to bow outward near the ends of the anodes 48 and 49. That phenomenon is a manifestation of throwing power and tends to produce greater current density at the lateral edges of the wire portion 9. The thieving rods 43 absorb the excess current flow to preserve a uniform current density over the wire portion 9. FIG. 6 shows the same arrangement as FIG. 5 except that a shield 55 is placed over the anodes 48 and 49. FIG. 7 shows an alternative arrangement for eliminating the thieving rods 43 and preventing the production of current flow that tends to cause difficulties. The thieving rods 43 are removed to illustrate the resulting excess current flow absorbed in the lateral edges of the wire portion 9 causing excessively heavy chromium deposition on the lateral edges or selvage of the papermaking wire 1. FIG. 7 illustrates an alternative arrangement for achieving the same result as the embodiment shown in FIG. 5. The anodes 48 and 49 in FIG. 7 have no sleeves 56 on their overhanging ends, nor are there any thieving rods 43. Instead, masks 57 of inert material are placed between the anodes 48 and 49 and against the lateral edges of the wire portion 9. The masks 57, in effect, insulate the lateral edges of the wire portion 9 and eliminate the spurious current paths resulting from the throwing power of the chromium ion electrolyte 33.

It will be noted that in all the embodiments shown, the wire portion 9 is spaced about twice as far from the lower anode 49 as from the upper anode 48. The reason for this spacing is to aid in accommodating the thickness in coating referred to in the above-mentioned copending application. The electrolyte 33 presents a resistance to the flow of current dependent upon the distance through which the current must flow in the electrolyte 33. Hence, all other things remaining constant, by increasing the distance between the lower anode 49 and the outer surface of the wire portion 9, the current density, and hence, chromium deposition to the outside of the wire portion 9 may be reduced. The opposite result is, of course, achieved with regard to the inside surface of the wire portion 9 by reducing the distance between upper anode 48 and the wire portion 9. This result could also be obtained by maintaining any given distance between the anodes 48 and 49 and inserting resistance into the external circuit, such as is shown in the current controls 46 and 47.

A wash system for the wire is an important part of the apparatus, for it serves three distinct purposes. A spray pipe 58 with a row of jets 59 extending along its length is positioned just behind the back conductor roll 4 to spray water upward at an angle from the bottom of the tank 27. This spray water upwashed at an angle from the bottom of the tank 27 will tend to wash the lower anode 49 to wash the wire 1 and to promote good electrical contact between the roll 9 and the wire 1. Again, a doctor 62 is provided beneath the front spray pipe 61 to direct an air blast to the wire to dry the wire 1, and hence, chromium deposition to the outside of the wire 1 as it leaves the wire portion 4 to remove as much of the water as possible to prevent dilution of the electrolyte 33. A second spray pipe 61 with jets 59 extending along its length is positioned just behind and beneath the front conductor roll 5 to spray water on the wire 1 and the roll 5 to wash us much of the electrolyte 33 as possible from the wire 1 before it reaches the anodes 48 and 49, to wash the roll 5, and to promote good electrical contact between the roll 5 and the wire 1. Again, a spray pipe 66 with jets 59 along its length plays a stream of water on the wire 1 after it leaves the front conductor roll 5 to ensure removal of any remaining traces of electrolyte 33 on the wire 1.

Finally, a fume control means is required to eliminate the potentially dangerous hydrogen gas generated by the electrolytic process and to protect the wire 1 from fumes and vapors arising from the electrolyte 33. In the embodiment shown, a hood 63 which is connected to an exhaust fan (not shown) and thence to an outlet (not shown) provides the necessary fume control means. The hood 63 is suspended on roller means 64 from the track 20 over the entire length of the plating tank 27.

The process of the present invention may be most conveniently described in connection with the description of the drawings. However, it is to be understood that the process may also be practiced on different apparatus. Hence, the scope of the process is not to be confined to the apparatus shown in the drawings, or any part thereof, but rather is to be defined by the claims.

To prepare the apparatus for use, the hood 63 is rolled out along the track 20, away from the tank 27. Next, the upper anode 48 is lifted upward and hung from the track 20 by means of the hooks 53, and slid outward away from the tank 27 on the track 20. The tank 27 is empty. The support rolls 2 that are to engage the side surface of the wire 1 are lifted out of their bearings 22, 25 and 26, and the contact roll 10, and the inert rolls 7 and 8 are removed. Finally, the track 20 must be removed. Then the wire 1 is laid on the table 11, the remaining support roll 2, and the conductor rolls 4 and 5 so that it rests above the lower anode 49. Next, the inert rolls 7 and 8, contact roll 10 and support roll 2 are inserted inside the endless wire 1 in their respective bearings. It is very important that the wire 1 be handled with the greatest care and that the proper tension be applied uniformly across its width. Since the wire 1 may be of a delicate 100 mesh count and still be up to 20 or 30 feet wide and 180 feet long, only the slightest mishandling is needed to destroy or severely damage the wire 1.
After the wire 1 has been mounted on the wire support and drive apparatus, the track 29 is replaced and then the upper anode 48 is moved along the track 29 so that the wire 1 is brought up to the temperature of the electrolyte 33 and the highly acidic bath cleans and conditions the surface of the wire. Thereafter, for a short distance from the inert roll 7 to the anodes 48 and 49 sufficient current passes through the electrolyte 33 to produce gassing on the wire 1, but not enough to effect a deposition of chromium. The current density gradually increases as the wire 1 approaches the anodes 48 and 49 until deposition occurs and full current density is achieved. Hence, when the wire portion 9 is presented between the anodes 48 and 49, its surface is in the ideal condition to receive the deposition of chromium. As a result, it is now possible to electroplate wires 1 without previous conditioning or intermediate plating and though a gradual increase in current density it is now possible to achieve an overplate that responds to all known tests and analyses as a single homogeneous layer.

Care must be taken not to bathe the wire 1 in the electrolyte 33 for too long a time and to wash the plated wire 1 clean of electrolyte 33 as soon as possible after it emerges from the electrolyte 33. The acidic electrolyte 33 will not only clean the surface of the wire 1, it will also react with copper in those brass or bronze strands and ultimately dissolve the strands given enough time. Even in a seemingly short time the strands may be undesirably roughened by etching if the wire 1 is bathed too long in the hot electrolyte 33. Although the electrolyte 33 will not etch the copper anode coating, it will leave an insoluble stain on the electroplated chromium coated wire 1 if not washed from the wire 1 as it leaves the tank 27. The acidic electrolyte 33 will also react with the copper surface of the roll 5. Hence, the front spray pipe 61 is positioned so that the water sprayed from its jets 59 will play on both the wire 1 and the roll 5.

As was noted above, the spray pipes 58 and 61 serve other, very important functions in effecting a good electrical contact between the conductor rolls 4 and 5 and the wire 1 and cooling the wire 1. In both instances it will be noted that the spray pipes 58 and 61 are positioned behind the respective conductor rolls 4 and 5 to wash the wire 1 just before and as it contacts the rolls 4 and 5. Previous efforts to chromium plate papermaking wires 1 resulted in holes being burned in the wire 1. It was discovered that the burning of the wire was the result of poor electrical contact between the wire 1 and the conductor rolls 4 and 5. Due to the extraordinary dimensions mentioned above of so delicate a fabric as the wire 1, maintaining absolutely uniform tension and length across the wire's entire width is not possible, and as a result, slight bellies form at random across the width of the wire 1, and where these bellies form, the wire 1 does not touch the conductor rolls 4 and 5. Since the wire 1 is, electrically, a massively complex series-parallel circuit of warp and weft strands, the points where the wire 1 contacts the rolls 4 and 5 must draw sufficient current to charge the entire wire 1. The heavy current load thus imposed on isolated points of the wire 1 is believed to cause the burning of the wire 1 at those points. Hence, the soft rubber contact roll 10 bears down on top of the wire 1 as it contacts the back conductor roll 4 to help effect a more uniform electrical contact. In addition, the water sprayed on the wire 1 and the rolls 4 and 5 effects an electrical contact across the entire surface of the wire 1 even where mechanical contact is not achieved and the fluid serves to cool the wire 1 during its contact with the rolls 45, inhibiting tendencies to overheat.

Once the desired weight and type of deposition is established, three major variables of the process remain to be worked out, namely: time, current density and temperature. Since the wire 1 is considerable in length, it will be treated in terms of speed of movement. Current density is current flow per unit of area, and this has been treated as the independent variable here. The following values are meter readings taken at the current source 40 of the embodiment described here: 30 amps is applied per inch of width of the wire 1 through the upper anode 48 and the inner surface of the wire 1; 15 amps is applied...
per inch of width of wire 1 through the lower anode 49 and the outer surface of the wire 1; and the voltage between the anodes 48 and 49 is held within the range of 5 to 10 volts and usually at around 7 volts. In calculating current densities, it has been found that the area of a papermaking wire 1 is not its apparent area or the area of a flat sheet of the same length and width. The effective area of the wire 1 is the sum of the surface areas of all of its strands. Hence, the current density resulting from the above values works out to about two amps per square inch on the inside of the wire 1 and about one amp per square inch on the outside of the wire 1. At those current values it has been found that the desired weight of deposition is achieved on the wire 1 moving at the rate of 1.2 inches per minute.

Chromium plating on the scale described would generally require about thirty-five hundred gallons of electrolyte 33. A plating tank large enough to accommodate the necessary volume of electrolyte would not only be cumbersome to work with, but would be rather futile since only a small portion of its volume, near the surface of the electrolyte 33 would be used so that the effective volume of electrolyte in any event would be substantially less than required. This problem is solved by the use of a plating tank 27, which is just sufficiently large to accommodate the wire 1, anodes 48 and 49, and the inert roll 7. The diminutive 160 gallon capacity of the tank 27 then turns out to be an advantage for it facilitates an even, thorough circulation of the electrolyte from the outlets 39 of the distribution pipe 38 along the back of the tank 27 forward across the tank 27 and out through the overflow holes 33 through the front wall 30 into the overflow chamber 31. From the overflow chamber 31, the electrolyte 33 flows through the return conduit 34 to the reservoir 35 where it is thoroughly mixed with replenished by the approximately thirty-three hundred gallons of electrolyte 33, which is maintained at a temperature in the range of about 110° F. to 130° F. Meanwhile, the pumping means 37 continues to replenish the supply of electrolyte 33 in the tank 27 at the rate of about 20 gallons per minute. This constantly circulating electrolyte 33 ensures a substantially constant ion concentration and temperature between the anodes 48 and 49 and the wire portion 9. The circulation also inhibits the collection on wire 1 of the sludge which is formed in the electrolytic process described.

A special problem regarding electrolyte 33 concentration arises in the use of the apparatus described. No way has been found to prevent completely the entry of the wash water from the paper pipe into the electrolyte 33. The doctors 60 and 62, while minimizing the amount of water reaching the electrolyte 33, cannot prevent it completely. Hence, it was, at first, found to be necessary to add chromic acid to the reservoir continuously. However, it has been learned that an intermittent spray of water, instead of a continuous spray, is sufficient and that by properly timing the sprays, it is possible to limit the amount of water added to the electrolyte 33 to the amount driven off by the electrolytic action and evaporation. Hence, dilution is avoided.

Uniformity of deposition is a prime requisite of a chromic coating for a papermaking wire. In the embodiment shown two anodes 48 and 49 are utilized to maintain precise control of the electrolytic process on both sides of the wire portion 9 even though the effective area of the wire portion 9 for each anode 48 and 49 is the sum of the entire areas of all of the strands. Of equal, if not greater importance is the use of anode sleeves 56 as shown in FIGS. 2–5, or masks 57 as shown in FIG. 7. The absence of either of those devices for preventing concentration of current density at the edges of the wire portion 9, as shown in FIG. 6, results in a deposition on the selavage of the wire 1 of such thickness as to cause premature fatigue failures when the wire 1 is put into use on a papermaking machine. In the arrangement shown in FIG. 5, part of the excess current is blocked by the anode sleeve 56 and the remainder is absorbed by the theing rods 43, which are one-eighth inch in diameter and which will receive about a sixteenth inch coating of chromium in the course of plating a single wire 1. The theing rods 43 should be replaced after each wire 1 is plated. A more efficient alternative is shown in FIG. 7 where masks 57 of plastic are positioned between the anodes 48 and 49 against the edge of the wire portion 9 to block off and eliminate additional current flow resulting in excess current density along the edges of the wire portion 9.

It has been found that the weight of deposition decreases as the mesh count increases when the meter readings and speed are held constant. Hence, if a uniform weight of deposition is desired, it is advisable to increase the current fed to the system for plating the finer mesh wires. It was also found that the rate of deposition varies substantially linearly with the current density achieved. If the optimum weight of deposition is sought, the speed at which the wire may be moved will increase linearly with the current density. It follows that the time required to plate a papermaking wire may be reduced by a corresponding increase in current density.

In the foregoing description, many quantitative parameters are set forth for the preferred embodiment of the present invention, in the drawings. The purpose of the detailed description is to set forth an embodiment of the present invention in such detail as to permit one skilled in the art to practice the invention, to make the apparatus, to work the process. On the other hand, the specific values set forth as limitations on a preferred embodiment are not necessarily limitations on the present invention. For example, with the same output from the current source 40, the current density achieved may be varied through a wide range by changing the dimensions of the width of the anode. However, since the anodes used in the specific embodiment described here are 9 inches wide, many of the specific values set forth are applicable only when used with anodes of that dimension. Also, a change in the electrolyte could effect many of the values set forth. However, on the basis of the foregoing disclosure one skilled in the art might calculate those and many other variations which could be made without departing from the present invention, which is set forth in the following claims:

We claim:

1. In a process for continuously electroplating a papermaking wire, the steps comprising:

- passing a papermaking wire across and in electrical connection with a negatively charged surface;
- successively immersing portions of said papermaking wire in a chromium ion bearing electrolyte at a point electrolytically remote from a positively charged anode to permit said electrolyte to condition said papermaking wire preparatory to plating;
- moving said portions of papermaking wire through said electrolyte past in close proximity to a positively charged anode immersed in said electrolyte.

2. In a process for continuously electroplating a papermaking wire, the steps comprising:

- moving a papermaking wire in engagement and electrical connection with a negatively charged surface;
- spraying fluid on said negatively charged surface and said wire to ensure electrical contact between said surface and said wire;
- immersing successive portions of said wire in a crystallized chromium ion containing electrolyte at a point electrolytically remote from a positively charged anode to permit said electrolyte to condition said papermaking wire preparatory to plating;
- moving said wire portions through said electrolyte in close proximity to a positively charged anode at an angle from horizontal;
isolating both edges of said papermaking wire from excess current flow when said papermaking wire is in close proximity with said anode; and thoroughly washing said papermaking wire after said papermaking wire leaves said electrolyte.

3. A process for continuously coating a papermaking wire with chromium comprising the steps of:
   mounting a papermaking wire upon wire supporting and drive mechanism;
   causing said wire to travel through a controlled temperature chromium ion electrolyte between a pair of anodes, which anodes extend across a width of said wire, so that before said wire enters between said anodes it is maintained electrolytically remote from said anodes;
   connecting said wire and said anodes across a controlled output unidirectional current source to impart a negative potential substantially uniformly across the width of said wire relative to said anodes; and moving said wire through said electrolyte at a substantially constant speed relative to said controlled output of said current source.

4. In an apparatus for continuously electroplating a papermaking wire, the combination comprising:
a plating tank adapted to receive circulating chromium ion containing electrolyte and opening upward, having a front and a back and being of size sufficient to permit a papermaking wire to be drawn through it from back to front;
an anode of effective length approximately equal to the width of said wire and mounted in said tank;
a plurality of wire supporting rolls, at least one of said rolls being a drive roll to move said papermaking wire at a controlled speed about said rolls, two of said rolls being front and back conductor rolls mounted respectively above the front and back of said tank, and two of said rolls being inert rolls mounted to guide said papermaking wire between said anode, at least one of said inert rolls being mounted behind said anode to be partially immersed in said electrolyte; said conductor rolls and said anodes being adapted for connection to opposite poles of a controlled unidirectional current source so that said conductor rolls may impart a substantially uniform negative potential to said papermaking wire relative to said anodes; an inert shield mounted behind said inert roll partially immersed in said electrolyte; and spray means for spraying fluid on said papermaking wire and said conductor rolls.

References Cited

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Date</th>
<th>Inventor</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,934,643</td>
<td>11/1933</td>
<td>Rafton</td>
<td>204—24</td>
</tr>
<tr>
<td>1,953,484</td>
<td>4/1934</td>
<td>Iredell</td>
<td>204—207</td>
</tr>
<tr>
<td>2,232,019</td>
<td>2/1941</td>
<td>Beckwith</td>
<td></td>
</tr>
<tr>
<td>2,372,599</td>
<td>3/1945</td>
<td>Nachtman</td>
<td>204—141</td>
</tr>
<tr>
<td>2,461,556</td>
<td>3/1949</td>
<td>Lorig</td>
<td>204—209</td>
</tr>
<tr>
<td>2,619,454</td>
<td>11/1952</td>
<td>Zapponi</td>
<td>204—213</td>
</tr>
<tr>
<td>3,113,845</td>
<td>12/1963</td>
<td>Uchida et al.</td>
<td>204—34</td>
</tr>
<tr>
<td>3,177,113</td>
<td>4/1965</td>
<td>Golden et al.</td>
<td>204—24</td>
</tr>
</tbody>
</table>

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