This invention discloses a conductor roll that is surrounded by a crown that extends along a substantial portion of the length of the conductor roll. The crown is designed to compensate for the deflection of the conductor roll when the conductor roll is placed under a load.
FIG. 6
APPARATUS AND METHOD FOR IMPROVING CONTACT BETWEEN A WEB AND A ROLL

FIELD OF THE INVENTION

[0001] This invention relates to electrocoating or electropolishing conductor rolls. Specifically, this invention relates to a crown that is designed to compensate for the deflection of the conductor roll when the conductor roll is subjected to a mechanical load.

BACKGROUND OF THE INVENTION

[0002] In a typical electrocoating process, a metal substrate is coated by utilizing an electric current to deposit a coating onto the substrate. The metal substrate, which may be either anodic or cathodic, carries the electrical current that is used by the chemical reactions that deposit the coating onto the surface of the substrate. In processes commonly referred to as electroplating (e.g., electrogalvanizing and electrotinning) the metal substrate is cathodic. In contrast, the metal substrate is anodic in processes often referred to as anodizing. In other electrocoating processes, the metal substrate may be either cathodic or anodic depending upon the desired chemistry of the end product.

[0003] An electrocoating process usually refers to processes in which the substrate is coated with an organic or polymeric coating often referred to as paint. The painted substrate is then cured for a predetermined amount of time to ensure that the components of the paint (i.e., pigment and resin) are sufficiently cross-linked and adhered to the surface of the substrate. Electrocoating presents a number of advantages over traditional painting processes. For instance, the amount of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and hazardous wastes are dramatically reduced or are completely eliminated when electrocoating is used in place of traditional painting processes. Additionally, electrocoating yields a more uniform coating on the surface of the metal substrate when compared to the traditional techniques of spraying, dipping, or roll coating thereby leading to a more superior end product.

[0004] When the substrate that is to be coated is a metallic sheet, one or more conductor rolls are typically used in the electrocoating or electropolishing process. As the metallic sheet travels over a rotating conductor roll, an electrical current passes between the contacting surfaces of the metallic sheet and the conductor roll. The continuous integrity of the electrical contact between the metallic sheet and the conductor roll, however, is critical in avoiding a metallic sheet defect commonly known in the art as arc spots or arc pits (i.e., holes in the sheet). In the electrocoating process, arc pits form when the contact between the metallic sheet and the conductor roll is reduced to such a degree that the resulting electrical current density at the remaining contact points or contact areas causes through thickness melting of the metallic sheet. The actual holes in the metallic sheet are formed as melted material is expelled from the sheet as the temperature and pressure of the air or other gases and vapors between the metallic sheet and the conductor roll rises. The electrical contact between the metallic sheet and the conductor roll is typically reduced by the introduction of air or other insulating substances between the contacting surfaces of the metallic sheet and the conductor roll.

[0005] Two counter measures have been used to reduce the occurrence of arc pits. First, the total amount of electrical current that is used in the electrocoating system can be significantly reduced. This, however, can have a negative impact on the rate of production since the amount of time needed to coat the metal substrate would increase thereby adding to the total amount of time needed to produce an end product. Second, a hold down roll can be used to minimize or prevent air or other fluids, gaseous or liquid, from being introduced between the contacting surfaces of the metallic sheet and the conductor roll by providing a force that constantly pushes the metallic sheet against the conductor roll. When used in tandem, these counter measures have had some success at reducing the occurrence of arc pits in an electrocoated metal substrate.

[0006] In this invention, it has been found that matching the conductor roll design to sheet tension, especially when used in combination with a hold down roll, has further reduced the occurrence of arc pits during the electrocoating process. Generally, the mechanical load on a conductor roll increases as the wrap angle of a sheet that is wrapped around the conductor roll increases. As can be seen in FIG. 1, a metallic sheet 2 travels around the conductor roll 4 in the direction of arrow Z at a wrap angle A of about 180° with a hold down roll 6 providing means for preventing the introduction of air between the metallic sheet 2 and the conductor roll 4. Even though FIG. 1 depicts the wrap angle A as being about 180°, it is noted that the wrap angle A can range from about 30° to about 200°. As the wrap angle A increases, the deflection of the conductor roll 4 also increases. The deflection in the conductor roll 4 can cause the metallic sheet 2 to gather in the region of maximum deflection thereby causing the metallic sheet 2 to partially lose contact with the conductor roll, which ultimately leads to the formation of arc pits in the metallic sheet 2.

[0007] Therefore, there exists a need for reducing or eliminating the deflection of the conductor roll during an electrocoating process.

[0008] This invention is a response to this need by disclosing a conductor roll with a crown profile that compensates for the deflection of the conductor roll, which is caused by a mechanical load, during the electrocoating process.

SUMMARY OF THE INVENTION

[0009] This invention discloses an apparatus for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process. The apparatus includes a conductor roll that is surrounded by a crown, which extends along a substantial length of the conductor roll. The crown is designed to compensate for the deflection of the conductor roll when the conductor roll is placed under a load. The apparatus also includes a hold down roll that is positioned adjacent to the conductor roll thereby applying pressure to the metallic sheet that passes between the opposing surfaces of the conductor roll and the hold down roll.

[0010] This invention also discloses a conductor roll that is surrounded by a crown, which extends along a substantial length of the conductor roll. The crown is designed to compensate for the deflection of the conductor roll when the conductor roll is placed under a load.

[0011] This invention also discloses a method for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process including providing a
metallic sheet, feeding the metallic sheet between the opposing surfaces of a crowned conductor roll and a hold down roll, wrapping the metallic sheet around the crowned conductor roll wherein the crowned conductor roll is deformed by the mechanical forces resulting from the sheet tension, and applying an electrical current through the crowned conductor roll to electrochemically deposit a coating onto a surface of the metallic sheet.

0012 This invention also discloses a metallic sheet manufactured by the process including providing a metallic sheet, feeding the metallic sheet between the opposing surfaces of a crowned conductor roll and a hold down roll, wrapping the metallic sheet around the crowned conductor roll wherein the crowned conductor roll is deformed by the mechanical forces resulting from the sheet tension, and applying an electrical current through the crowned conductor roll to electrochemically deposit a coating onto a surface of the metallic sheet.

0013 This invention also discloses a method for making a conductor roll for use in an electrocoating line process including providing a conductor roll, measuring or predicting the amount of deflection of the conductor roll when a metallic sheet is wrapped around the conductor roll, and fabricating a crown that surrounds and extends along a substantial length of the conductor roll. The crown is designed to compensate for the deflection of the conductor roll when the conductor roll is placed under a load.

0014 One aspect of this invention is to reduce or eliminate the occurrence of arc pits in a metallic sheet during an electrocoating process.

0015 Another aspect of this invention is to fabricate a crown that can compensate for the deflection of a conductor roll when the conductor roll is under a load.

BRIEF DESCRIPTION OF THE DRAWINGS

0016 FIG. 1 is a side or end view showing a metal sheet, conductor roll, and hold down roll as described in the present invention.

0017 FIG. 2 is a front view depicting a typical conductor roll under no load.

0018 FIG. 3 is a front view depicting a typical conductor roll under a load.

0019 FIG. 4 is a front view depicting a conductor roll, which is under no load, having a crown profile as described in the present invention.

0020 FIG. 5 is a front view depicting a conductor roll, which is under a load, with a crown as described in the present invention.

0021 FIG. 6 is an overhead view of the conductor roll and the hold down roll as described in the present invention.

0022 FIG. 7 is a side or end view showing a metal sheet, conductor roll, hold down roll, coating stations, and curing stations as described in the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

0023 The accompanying figures and the description that follow set forth this invention in its preferred embodiments. However, it is contemplated that persons generally familiar with electroplating conductor rolls will be able to apply the novel characteristics of the structures and methods illustrated and described herein in other contexts by modification of certain details. Accordingly, the figures and description are not to be taken as restrictive on the scope of this invention, but are to be understood as broad and general teachings. When referring to any numerical range of values, such ranges are understood to include each and every number and/or fraction between the stated range minimum and maximum. For purposes of the description hereinafter, the terms “upper”, “lower”, “right”, “left”, “vertical”, “horizontal”, “top”, “bottom”, and derivatives thereof shall relate to the invention as it is oriented in the drawing figures.

0024 The term “crown” is generally understood in several industries, which use rolls or rollers, to mean a general barrel-shape. In other words, the mid section of the roll has a larger diameter than the ends of the roll.

0025 This invention discloses a crowned conductor roll that is designed to compensate for the deflection of the conductor roll when the conductor roll is subjected to mechanical forces, e.g. sheet tension, gravity, brush assemblies, and hold down rolls, during an electrocoating process thereby reducing or eliminating the occurrence of arc pits in the metallic sheet. In addition, by utilizing a crown to compensate for the conductor roll’s deflection, a lighter and smaller diameter conductor roll can be used in the electrocoating process since the roll itself would not have to be so strong as not to deflect or bend when subjected to the mechanical forces that occur during the electrocoating process. Yet another advantage of using a crowned conductor roll is that when it is determined that the deflection of a standard cylindrical or non-crowned conductor roll is detrimental, modification of the super structure of the electrocoating or electroplating line is most often not necessary. This is due to crowned rolls being substantially the same size (i.e., length, weight, and diameter) as the standard cylindrical roll that they will replace.

0026 FIG. 2 depicts a typical conductor roll 4 under no mechanical load and having no deflection. As can be seen from FIG. 2, the conductor roll 4 has a first end 8, a second end 10, an outer surface 12, a top 14, and a bottom 16. The outer surface 12 of the conductor roll 4 is the surface of the conductor roll 4 that comes into direct contact with the metal sheet (not shown). Extending substantially laterally from each of the first and second ends 10 and 12 is a centrally located shaft 18, which is used as a means for rotating the conductor roll 4 about its axis.

0027 FIG. 3, in contrast, depicts a conductor roll 4 having a deflection λ that is caused by a mechanical load as represented by arrow L. The mechanical load L is due to a combination of sheet tension, which is exerted onto the conductor roll 4 when a metallic sheet (not shown) is wrapped around the conductor roll 4, and other forces that are present in the electrocoating process. As can be seen from FIG. 3, the deflection λ is the distance between the top 14 of the conductor roll 4 and a line 20, which represents the position of the top 14 of the conductor roll 4 when the conductor roll 4 is under no load. In general, the deflection
\( \lambda \) is greatest about the center of the conductor roll 4 and
reduces in distance towards the first and second ends 8 and 10. In other words, the conductor roll 4 is substantially bent
when the conductor roll 4 is under the mechanical load. It is
noted, however, that the location of maximum deflection \( \lambda \)
does not necessarily have to be near the center of the
conductor roll 4 since the location of maximum deflection \( \lambda \)
is dependent upon the particular mechanical forces that are
acting on the conductor roll 4. In one embodiment, when the
wrap angle of the sheet is about 180° the deflection \( \lambda \) of a
specific conductor roll is about 0.0254 cm (0.010 inches)
about the center of the conductor roll 4.

[0028] Referring to FIG. 4, the shape of the crown 22 is
very specific to the deflection \( \lambda \) that it is designed to
compensate for. The crown 22, however, may be generally
categorized as having one end of the crowned conductor roll 24 with a specified diameter. The diameter along the
length of the roll 4, between the first and second ends 8 and 10, is not constant. In other words, the crowned conductor roll 24 is not a true geometric cylinder, which is contrary to
that of traditional conductor rolls commonly used in web or
sheet handling processes. From the first end 8, the diameter
of the crowned conductor roll 24 increases monotonously
along the length of the crowned conductor roll 24. At a
location along the length of the crowned conductor roll 24
the diameter of the crown 22 reaches a maximum value. It
is noted that the location along the length of the crowned
conductor roll 24 where the diameter has its maximum value
is not constrained to the centerline 26 of the crowned
conductor roll 24. Rather, the specific design of the crown 22
is determined by the design of the conductor roll and the
mechanical forces that are acting to cause the conductor roll
to deflect or bend. From the point of maximum value the
diameter of the crowned conductor roll 24 monotonously
decreases toward the second end 10. In one embodiment, the
diameters of the first and second ends 10 and 12 are not
equal.

[0029] By knowing the amount of deflection \( \lambda \) across
the length of the conductor roll 4, a crown 22 can be incorpo-
rated into the shape of the conductor roll 4 or positioned
around the conductor roll 4 in a form of a jacket to fully
compensate for the deflection \( \lambda \) of the conductor roll 4
thereby ensuring that the top of the crowned conductor roll
24 is oriented as if the crowned conductor roll 24 was under
no load. As shown in FIG. 5, when the crowned conductor roll 24 is in use the crown 22 reduces the likelihood that a
metallic sheet 2 would gather under high tension since the
top 23 of the crown 22 would be a substantially straight line
(i.e. flat or even).

[0030] FIG. 4 depicts a crowned conductor roll 24, which
is under no load, having a crown 22 that is incorporated into
the shape of the conductor roll 4 by design. As can be
understood from FIG. 4, \( \alpha \) is the distance between the top
14 and bottom 16 of the crowned conductor roll 24 and a line
20. As in FIG. 3, the line 20 in FIG. 4 represents the position
of the top 14 and bottom 16 of a conductor roll 4, without
a crown, when the conductor roll 4 is under no load.
Referring to FIG. 4, \( \alpha \) is greatest about the centerline 26 of
the crown 22 and reduces in distance as the crown 22
approaches the first and second ends 8 and 10. This is not
meant to be limiting, however, since \( \alpha \) can have its max-
imum value (i.e. distance) anywhere along the length of the
crown 22 since the deflection \( \lambda \) that \( \alpha \) is compensating for
is dependent on the particular forces that are acting on the
conductor roll 4. When designing the crown 22 into the
shape of a conductor roll, \( \alpha \) must be substantially equal to
the deflection \( \lambda \) in order for the crown 22 to effectively
compensate for the deflection \( \lambda \).

[0031] It is contemplated that when the crowned conduc-
tor roll 24 rotates about its axis 28 the design of the crowned
conductor roll 24 is symmetric about the axis 28 when the
crowned conductor roll 24 is under no load. It is also
contemplated that the deflecting forces acting on the
crowned conductor roll 24 may not be symmetric about the
center line 26 of the crowned conductor roll 24. When the
deflecting forces are not symmetric about the center line 26,
the maximum value of \( \alpha \) will correspondingly not be located
about the centerline 26. It is additionally contemplated that
the magnitude of \( \alpha \), the location of \( \alpha \), and the detailed shape
of the crown 22 will be significantly specific to the loads
causng the deflection \( \lambda \). When the crowned conductor roll
24 is in use, however, the top 23 of the crown 22, which is
located at or near the midpoint B or B’ of the wrap angle A
as shown in FIG. 1, will be substantially straight (i.e. flat or
even).

[0032] FIG. 5 shows a crowned conductor roll 24 under a
mechanical load L, which is caused by the sheet tension or
other forces that are exerted onto the crowned conductor roll
24 when a metal sheet (not shown) is wrapped around the
crowned conductor roll 24 at a wrap angle ranging from
about 30° to about 200°. Unlike the conductor roll 4 in FIG.
3, however, the top 14 of the crowned conductor roll 24 in
FIG. 5 is substantially a straight line (i.e. flat or even). This
is due to the crown 22 compensating for the deflection \( \lambda \)
when the crowned conductor roll 24 is under the load L. By
having a crowned conductor roll 24 with a substantially
straight top 14, the formation of arc pits in the metallic sheet
is substantially reduced or eliminated since the forces that
cause sheet gathering are reduced or eliminated thereby
enabling the metallic sheet and the top 14 of the crowned
conductor roll 26 to be in constant contact thereby reducing
or preventing the introduction of air or liquid between the
contacting surfaces. As can be understood from FIG. 5, the
bottom 16 of the crowned conductor roll 24, which is not
presently in contact with the metallic sheet, will have a
distance of 2\( \alpha \).

[0033] The crown 22 is formed in the following manner.
First, the amount of deflection of the conductor roll 4 is
measured or modeled using techniques that are well known
in the art. For instance, the computer method of Finite
Element Modeling (FEM) or a similar method can be used
to measure, predict, or model the amount of deflection \( \lambda \).
Once the deflection \( \lambda \) has been measured or predicted, the
exact dimensions of the crown 22 are calculated to com-
penstate for the deflection \( \lambda \). A layer is then deposited over
the outer surface 12 of the conductor roll 4 using methods
that are commonly known in the art such as electroplating,
thermal spraying, and cold spraying. It is noted that thermal
spraying also includes, but is not limited to, plasma spray-
ing, high velocity powder combustion, high velocity wire
combustion, and wire arc. The crown 22 is then formed by
machining the layer to the dimensions required to compen-
sate for the deflection \( \lambda \). As described in the preceding
paragraphs, the diameter of the crown 22 is designed to
increase and to decrease monotonously along the length of
the conductor roll 4 by a distance of \( \alpha \), which is substantially
equal to the deflection \( \lambda \), thereby fully compensating for the deflection \( \lambda \) that is caused by the mechanical load. The deposited layer is shaped using methods that are commonly known in the art including but not limited to, grinding, polishing, and electron discharge machining (EDM).

[0034] In one embodiment, the deposited layer has a maximum thickness of about 0.254 cm (0.1 in).

[0035] In another embodiment, the deposited layer can be chromium, inconel, or alloys based on iron, nickel, or chromium. This, however, is not meant to be limiting since any material that exhibits wear resistance, adequate electrical conductivity, and adherence to the roll substrate may be used without departing from the teachings of this invention.

[0036] In another embodiment, the metal that was used to fabricate the conductor roll 4 was steel. However, the conductor roll 4 may also be fabricated from other metals or metal alloys.

[0037] In another embodiment, the maximum dimension of the crown 22 is at most about 0.025 cm (0.01 in) higher than either the first or second end 8 and 10.

[0038] In yet another embodiment, the crown 22 is able to conduct an electrical current up to about 70,000 amperes.

[0039] In another embodiment, the crown 22 is able to conduct an electrical current ranging from about 3,000 amperes to about 70,000 amperes. This is not meant to be limiting, however, since the crown 22 would also be able to conduct an electric current that is less than 3000 amperes.

[0040] In another embodiment, the surface of the crown 22 has a maximum Ra surface roughness of about 0.127 \( \mu \text{m} \) (5 \( \mu \text{m} \)). It is noted that one having ordinary skill in the art would understand this is meant by a Ra surface roughness.

[0041] In another embodiment, the surface of the crown 22 has a maximum Ra surface roughness of about 0.508 \( \mu \text{m} \) (2 \( \mu \text{m} \)).

[0042] In another embodiment, the surface of the crown 22 has a maximum Ra surface roughness of about 0.0254 \( \mu \text{m} \) (1 \( \mu \text{m} \)).

[0043] In another embodiment, the crown 22 is fabricated as a jacket from a metal or a metal alloy. The conductor roll 4 is then inserted into the jacket so that the conductor roll 4 is substantially surrounded by the crown 22. Once the crown 22 is positioned around the conductor roll 4 they are joined or affixed using techniques that are commonly known in the art such as welding, brazing or soldering thereby forming a crowned conductor roll 24.

[0044] In yet another embodiment, the metallic sheet has a thickness ranging from about 0.0127 cm (0.0050) to about 0.254 cm (0.1 in).

[0045] In another embodiment, the line speed is at least about 91 meters/minute (300 feet/minute).

[0046] In another embodiment, the crown extends substantially along the entire length of the conductor roll.

[0047] In another embodiment, the crown extends substantially along more than half of the length of the conductor roll.

[0048] FIG. 6 depicts the orientation of the crowned conductor roll 24 in relation to the hold down roll 6. As can be seen more clearly from FIG. 1, the hold down roll 6 is positioned in such a manner to maximize the physical contact between the metallic sheet 2 and the crowned conductor roll 24 with the aim of minimizing the amount of air or fluids that can be introduced between the sheet 2 and the crowned conductor roll 24. Referring back to FIG. 6, the hold down roll 6 has a first end 30 and a second end 32. Extending substantially laterally from the first and second ends 30 and 32 of the hold down roll 6 is a centrally located shaft 34 that is used as a means for rotating the hold down roll 6 about its axis. The pressure that is applied by the hold down roll 6 to the metallic sheet (not shown) is significant to the reduction or elimination of arc pits during the electrocoating process. If the amount of pressure that is applied by the hold down roll 6 to the metallic sheet 2 is too low, then the contact between the metallic sheet and the crowned conductor roll 24 may not be sufficient to prevent air and liquid from entering between the metallic sheet and the crowned conductor roll 24. If the pressure that is applied is too high, small pieces of debris between the metallic sheet and the crowned conductor roll 24 can cause the formation of dents on the metallic sheet as the debris is squeezed between the metallic sheet and the crowned conductor roll 24 during the electrocoating process. An ideal pressure is where the hold down roll 6 pushes against the metallic sheet with about the same force that the metallic sheet pushes against the crowned conductor roll 24 when the metallic sheet is wrapped around the crowned conductor roll 24.

[0049] Referring to FIG. 7, the metallic sheet 2 is unwound from a first coil or roll 36 and wrapped around the crowned conductor roll 24 at a wrap angle of about 180°, which causes the crowned conductor roll 24 to deflect. As stated above, the crown 22 is designed to compensate for the deflection of the crowned conductor roll 24 thereby reducing or eliminating the likelihood of the metallic sheet 2 to gather and develop arc pits. A hold down roll 6 is also used to ensure that the metallic sheet 2 remains in constant contact with crowned conductor roll 24. The metallic sheet is electrochemically coated in coating stations 38. The coating stations 38 contain a liquid bath 40 located within the interior 42 of the coating stations 38 through which the metallic sheet 2 passes. An electrical current is then applied to the crowned conductor roll 24 to electrochemically deposit the coating, which is in the liquid bath 40, onto the surface of the metallic sheet 2. After the coating has been deposited onto the metallic sheet 2, the coating may be cured in a curing station 44 at temperatures ranging from about 149° C. to about 316° C. (300° F. to 600° F.) and at cycle times ranging from about 5 seconds to about 35 seconds. Once the curing cycle is complete, the metallic sheet 2 is wound into a second roll or a coil 46 that can be distributed to downstream processes. One embodiment of a coating station 44 that may be used in conjunction with this invention is disclosed in U.S. Pat. No. 5,962,060.

[0050] Having described the presently preferred embodiments, it is to be understood that the invention may be otherwise embodied within the scope of the appended claims.

What is claimed is:

1. An apparatus for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process comprising:
a conductor roll;
a crown surrounds said conductor roll and extends along a substantial length of said conductor roll, said crown being designed to compensate for the deflection of said conductor when said conductor roll is placed under a load; and

a hold down roll is positioned adjacent to said conductor roll thereby applying pressure to said metallic sheet that passes between the opposing surfaces of said conductor roll and said hold down roll.

2. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 1 wherein said crown has a substantially straight top when said metallic sheet is wrapped around said conductor roll, said top of said crown being in direct contact with said metallic sheet.

3. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 1 wherein said crown is fabricated from a layer that is deposited over a surface of said conductor roll.

4. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 3 wherein said layer is chromium, inconel, or an alloy based on iron, nickel, or chromium.

5. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 3 wherein said layer is deposited over said surface of said conductor roll using electroplating, thermal spraying, or cold spraying.

6. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 5 wherein thermal spraying comprises plasma spraying, high velocity powder combustion, high velocity wire combustion, and wire arc.

7. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 1 wherein said surface of said crown has a maximum Ra surface roughness of about 0.127 μm (5 μin).

8. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 1 wherein said crown is able to conduct an electrical current up to about 70,000 amperes.

9. An apparatus for reducing or eliminating the occurrence of arc pits during an electrocoating process according to claim 1 wherein said crown is a jacket that surrounds and is affixed to said conductor roll.

10. A conductor roll comprising a crown that surrounds said conductor roll, said crown extending along a substantial length of said conductor roll, said crown being designed to compensate for the deflection of said conductor roll when said conductor roll is placed under a load.

11. A conductor roll according to claim 10 wherein said crown is fabricated from a layer that is deposited over a surface of said conductor roll.

12. A conductor roll according to claim 11 wherein said layer is chromium, inconel, or an alloy based on iron, nickel, or chromium.

13. A conductor roll according to claim 10 wherein said crown is a jacket that surrounds and is affixed to said conductor roll.

14. A conductor roll according to claim 10 wherein said crown has a substantially straight top when a metallic sheet is wrapped around said crown, said top of said crown being in direct contact with said metallic sheet.

15. A conductor roll according to claim 10 wherein said layer is deposited over said surface of said conductor roll using electroplating, thermal spraying, and cold spraying.

16. A conductor roll according to claim 15 wherein thermal spraying comprises plasma spraying, high velocity powder combustion, high velocity wire combustion, and wire arc.

17. A conductor roll according to claim 10 wherein a surface of said crown has a maximum Ra surface roughness of about 0.127 μm (5 μin).

18. A conductor roll according to claim 10 wherein said crown is able to conduct an electrical current up to about 70,000 amperes.

19. A method for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process comprising:

- providing a metallic sheet;
- feeding said metallic sheet between the opposing surfaces of a crowned conductor roll and a hold down roll;
- wrapping said metallic sheet around said crowned conductor roll wherein said crowned conductor roll is deformed by the mechanical forces resulting from the sheet tension; and

applying an electrical current through said crowned conductor roll to electrochemically deposit a coating onto a surface of said metallic sheet.

20. A method for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process according to claim 19 further comprising:

- providing a first roll or coil of said metallic sheet;
- unwinding said metallic sheet prior to feeding said metallic sheet between the opposing surfaces of said crowned conductor roll and said hold down roll; and

winding said metallic sheet into a second roll or coil after depositing said coating onto said surface of said metallic sheet.

21. A method for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process according to claim 19 further comprising curing said coating onto said surface of said metallic sheet after depositing said coating onto said metallic sheet.

22. A method for reducing or eliminating the occurrence of arc pits in a metallic sheet during an electrocoating process according to claim 19 wherein providing a first roll or coil of aluminum, aluminum alloy, steel, or steel alloy sheet.

23. A metallic sheet manufactured by the process comprising:

- providing a metallic sheet;
- feeding said sheet between the opposing surfaces of a crowned conductor roll and a hold down roll;
- wrapping said metallic sheet around said crowned conductor roll wherein said crowned conductor roll is deformed by the mechanical forces resulting from the sheet tension; and
applying an electrical current through said crowned conductor roll to electrochemically deposit a coating onto a surface of said metallic sheet.

24. A method for making a conductor roll for use in an electrocoating line process comprising:

providing a conductor roll;

measuring or modeling the amount of deflection of said conductor roll when a metallic sheet is wrapped around said conductor roll; and

fabricating a crown that surrounds and extends along a substantial length of said conductor roll, said crown being designed to compensate for the deflection of said conductor roll when said conductor roll is placed under a load.

25. A method of making a conductor roll according to claim 24 wherein fabricating a crown to compensate for said deflection of said metallic cylinder by depositing a layer onto a surface of said conductor roll thereby surrounding said conductor roll with said layer.

26. A method of making a conductor roll according to claim 25 wherein depositing said layer onto said surface of said conductor roll using electroplating, thermal spraying, or cold spraying.

27. A method of making a conductor roll according to claim 26 wherein depositing a layer of chromium, inconel, or an alloy based on iron, nickel or chromium; and

shaping said layer to compensate for said deflection of said conductor roll.

28. A method of making a conductor roll according to claim 24 wherein fabricating said crown so that a surface of said crown has a maximum Ra surface roughness of about 0.127 μm (5 μin).

29. A method of making a conductor roll according to claim 24 wherein fabricating a crowned jacket through which said conductor roll is inserted and affixed.

* * * * *