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(54) Title: ELECTROLYTIC CATHODE ASSEMBLY WITH PROTECTIVE COVERING AND INJECTED SEAL

(57) Abstract: An electrolytic cathode assembly includes an electrically conductive hanger bar, a deposition plate attached along an upper end to the hanger bar to define a joint, and a protective covering generally surrounding the hanger bar and a portion of an upper end of the deposition plate so as to substantially enclose the joint. The protective covering may be die formed from bending a sheet of material. A corrosion resistant material is injected into a channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar, thereby to at least hinder fluid flow into the protective covering.

FIG. 1
TITLE: ELECTROLYTIC CATHODE ASSEMBLY WITH PROTECTIVE COVERING AND INJECTED SEAL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/681,780 filed on August 10, 2012, the entire contents of which are hereby incorporated herein by reference.

FIELD

[0002] The present disclosure relates generally to electrolytic cathode assemblies typically used in the refining or winning of metals.

BACKGROUND

[0003] The following is not an admission that anything discussed therein is prior art or part of the knowledge of persons skilled in the art.

[0004] International Application No. PCT/CA2008/001470 describes an electrolytic cathode assembly, typically used in the refining or winning of metals, that has an electrically conductive hanger bar and a deposition plate attached along an upper end to the hanger bar to define a joint. The cathode assembly further comprises a protective covering having lateral edges and surrounding the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint and to leave end portions of the hanger bar exposed outside of the lateral edges of the protective covering. Each end of the protective covering includes a corrosion resistant material positioned to form a substantially continuous seal between the protective covering and the hanger bar, thereby to at least hinder fluid flow into the protective covering. Methods of manufacturing and using the electrolytic cathode assemblies are also described.

[0005] International Application No. PCT/CA2011/050656 describes an electrolytic cathode assembly including a hollow hanger bar, and a deposition plate including an upper edge attached to the hanger bar. The hanger bar can be formed substantially of copper. At least one supporting element can be
configured to support the hanger bar. The supporting element(s) can be internally disposed within the hanger bar, and can extend partially between bar ends of the hanger bar. The supporting element(s) can include first and second supporting elements, with each disposed adjacent to a respective one of the bar ends. The hanger bar can include an overhanging portion, and the supporting element(s) can be at least partially disposed within the overhanging portion. The supporting element(s) can include an inward end that is offset inwardly relative to the plate edges of the deposition plate.

INTRODUCTION

[00063] The following is intended to introduce the reader to the detailed description that follows and not to define or limit the claimed subject matter.

[0007] In an aspect of the present disclosure, a method of manufacturing an electrolytic cathode assembly may include: attaching a deposition plate along an upper end to an electrically conductive hanger bar to define a joint; forming a protective covering including a lateral edge; arranging the protective covering to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint; and injecting a corrosion resistant material into a channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar, thereby to at least hinder fluid flow into the protective covering at the lateral edge.

[0008] The step of forming may include forming the channel in the protective covering generally adjacent to the lateral edge. The step of forming may include forming the protective covering from a sheet of material. The step of forming may include bending the sheet of material to form sidewalls that define a central cavity for receiving the hanger bar. The step of forming may include bending the sheet of material so that the sidewalls of the protective covering are spaced apart to receive the hanger bar in sliding fit. The step of arranging may include bending the sidewalls to generally engage the hanger bar. The step of forming may include bending the sheet of material so that longitudinal edges of the protective covering are spaced apart to receive the
deposition plate in sliding fit. The step of arranging may include welding the longitudinal edges to the deposition plate.

[0009] The step of injecting may include injecting the corrosion resistant material into at least one access port in fluid communication with the channel. The step of forming may include forming the at least one access port in the protective covering. The step of forming may include forming the at least one access port in a top side wall of the protective covering in registration with the channel.

[0010] The method may further include disposing at least one supporting element internally within the hanger bar. The method may further include attaching the deposition plate to the hanger bar by at least one weld, and attaching the protective covering to the deposition plate by at least one weld. The corrosion resistant material may include an epoxy. The deposition plate and protective covering may be formed from stainless steel. The hanger bar may be formed from copper.

[0011] In an aspect of the present disclosure, an electrolytic cathode assembly may include: an electrically conductive hanger bar; a deposition plate attached along an upper end to the hanger bar to define a joint; a protective covering including a lateral edge, the protective covering arranged to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint; and a corrosion resistant material disposed in a channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar, thereby to at least hinder fluid flow into the protective covering at the lateral edge.

[0012] The channel may be formed in the protective covering adjacent to the lateral edge. The electrolytic cathode assembly may further include at least one access port in fluid communication with the channel. The at least one access port may be formed in the protective covering. The at least one access port may be formed in a top side wall of the protective covering in registration with the channel.
[0013] The electrolytic cathode assembly may further include at least one supporting element disposed internally within the hanger bar. The deposition plate may be attached to the hanger bar by at least one weld, and the protective covering may be attached to the deposition plate by at least one weld. The corrosion resistant material may include an epoxy. The deposition plate and the protective covering may be formed from stainless steel. The hanger bar may be formed from copper.

[0014] An electrolytic cell may include: a tank containing an electrolytic bath; an anode assembly contained within the electrolytic bath; the cathode assembly as described herein contained within the electrolytic bath; and a power source electrically connected to the anode assembly and the cathode assembly to form the electrolytic cell.

[0015] A method of electro-refining or electro-winning a metal in an electrolytic cell may include: providing a tank containing an electrolytic bath; providing an anode assembly in the electrolytic bath; providing the cathode assembly as described herein in the electrolytic bath; providing a power source; electrically connecting the power source to the anode assembly and the cathode assembly to form the electrolytic cell; and applying a sufficient amount of current to the electrolytic cell to cause metal ions from the electrolytic bath to be deposited onto a surface of the deposition plate of the cathode assembly.

[0016] In an aspect of the present disclosure, a method of forming a protective covering, for an electrolytic cathode assembly including an electrically conductive hanger bar and a deposition plate attached along an upper end to the hanger bar to define a joint, may include: providing at least one sheet of material; and bending the sheet of material to form sidewalls that define a central cavity for receiving a hanger bar of the electrolytic cathode assembly, wherein sidewalls of the protective covering are spaced apart to receive the hanger bar in sliding fit.

[0017] The step of bending may include at least one die forming operation. The sheet of material may be arranged to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to
substantially enclose the joint. Sidewalls of the sheet of material may be bent to generally engage the hanger bar. Longitudinal edges of the sheet of material may be welded to the deposition plate.

[0018] The method may further include forming a channel in the sheet of material, and injecting a corrosion resistant material into the channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar. The step of forming may include at least one die forming operation. The method may further include producing at least one access port in the sheet of material in fluid communication with the channel, and the step of injecting may include injecting the corrosion resistant material into the at least one access port. The step of producing may include at least one die forming operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The drawings included herewith are for illustrating various examples of apparatuses and methods of the present disclosure and are not intended to limit the scope of what is taught in any way. In the drawings:

Figure 1 is a partial side view of an electrolytic cathode assembly in accordance with a first example;

Figure 2 is a partial perspective view of the cathode assembly of Figure 1;

Figure 3 is an enlarged partial side view of a lateral end of the cathode assembly of Figure 1;

Figure 4 is a sectional view along line 4-4 in Figure 1;

Figure 5 is a sectional view along line 5-5 in Figure 1;

Figures 6 and 7 are partial perspective views of a lateral end of a protective covering of the cathode assembly of Figure 1, before and after at least a first forming step, respectively;

Figures 8, 9 and 10 are perspective, end and top views of the protective covering of Figures 6 and 7, after at least a second forming step;
Figure 11 is a reverse, enlarged partial perspective view of the lateral end of the cathode assembly of Figure 1; Figure 12 is a sectional view along line 12-1 2 in Figure 3; and Figure 13 is a schematic, perspective view of an exemplary electrolytic cell.

DETAILED DESCRIPTION

[0020] Various apparatuses or methods are described below to provide an example of an embodiment of each claimed invention. No embodiment described below limits any claimed invention and any claimed invention may cover apparatuses and methods that differ from those described below. The claimed inventions are not limited to apparatuses and methods having all of the features of any one apparatus or method described below or to features common to multiple or all of the apparatuses or methods described below, it is possible that an apparatus or method described below is not an embodiment of any claimed invention. Any invention disclosed in an apparatus or method described below that is not claimed in this document may be the subject matter of another protective instrument, for example, a continuing patent application, and the applicant(s), inventor(s) and/or owner(s) do not intend to abandon, disclaim or dedicate to the public any such invention by its disclosure in this document.

[0021] Electro-refining of metals requires placing an anode made from the crude metal to be refined and a cathode together in a suitable electrolytic bath. Application of a voltage between the anode and the cathode causes the crude metal to oxidize and pure metal ions to go into solution and to migrate electrolytically through the electrolytic bath towards the cathode. The pure metal ions are deposited onto the cathode as a refined metal, usually of very high purity. The majority of the impurities are left behind in the electrolytic bath.

[0022] Electro-winning of metals requires placing an anode made from a metal that is different from the metal to be refined and a cathode together in a suitable electrolytic bath. The metal to be refined is added to the electrolytic
bath in a soluble form (e.g., prepared from a leaching and solvent extraction process). Application of a voltage between the anode and cathode causes the metal to migrate from the solution and deposit onto the cathode as a refined metal of high purity.

[0023] A typical cathode assembly includes a flat deposition plate attached along an upper end to an electrically conductive hanger bar. The hanger bar is in electrical contact with an external power source. In some configurations, both ends of the hanger bar rest on an electrically conductive bus bar that runs along edges of the tank. In other configurations, one end of the hanger bar rests on an electrically conductive bus bar that runs along one edge of the tank and the other end of the hanger bar rests on an electrically insulated bar that runs along the opposite edge of the tank. The hanger bar supports the deposition plate within the electrolytic bath and provides a path for the flow of electricity between the power source and the deposition plate.

[0024] After a suitable thickness of refined metal has been deposited onto the surface of the deposition plate, the cathode assembly is removed from the electrolytic bath. In cases where the deposition plate is permanent (e.g., formed from a different metal than the metal to be refined), the refined metal may be recovered by any known stripping techniques. Often, vertical side edges of the deposition plate are covered or protected, so that deposition of copper or other desired metal occurs only on the flat side faces of the deposition plate and around a lower edge thereof.

[0025] In some cases, a cathode assembly includes an electrically conductive hanger bar (e.g., copper) coupled together with a permanent deposition plate (e.g., stainless steel). The upper end of the deposition plate is typically inserted into a slot or groove provided along the underside of the hanger bar. The deposition plate is then attached to the hanger bar with a weld. A hollow hanger bar may result in lower weight and less material costs. Examples of cathode assemblies are disclosed in International Application Nos. PCT/CA2008/001470 and PCT/CA2011/050656, and the entire contents of each are hereby incorporated herein by reference.
Referring to Figures 1 and 2, an electrolytic cathode assembly is shown generally at 10. The electrolytic cathode assembly 10 includes a hanger bar 12. The hanger bar 12 may be manufactured substantially from copper. In some examples, the hanger bar 12 may be manufactured from C11000 Electrolytic Tough Pitch (ETP) copper.

Referring now Figure 5, in the example illustrated, the hanger bar 12 is hollow. However, in some examples, the hanger bar may be solid. As illustrated, the hanger bar 12 may be shaped as a rectangular tube with a generally flat top and flat sides, and rounded on the bottom. While a rounded bottom is shown, the bottom could be flat, and in general the profile of the hanger bar 12 may be varied.

In examples where the hanger bar 12 is hollow, as illustrated, the electrolytic cathode assembly 10 may optionally include at least one supporting element 14 internally disposed within the hanger bar 12. An external profile of the supporting element 14 may be generally complementary to an internal profile of the hanger bar 12, ensuring a good fit so that the supporting element 14 may reinforce the hanger bar 12. The supporting element 14 may be secured to the hanger bar 12 by interference fit, adhesive, welding, or a combination thereof. As illustrated, the supporting element 14 also may be hollow, and may be shaped as a rectangular tube.

In the example illustrated, referring again to Figure 1, two of the supporting elements 14 are shown extending only partially between opposite ends of the hanger bar 12. Each of the supporting elements 14 are disposed adjacent to a respective end of the hanger bar 12, and are at least partially disposed within overhanging portions of the hanger bar 12 that extend beyond respective plate edges 18 of the deposition plate 16. In some examples, an inward end of the supporting element 14 may be offset inwardly relative to a respective one of the plate edges 18 of the deposition plate 16.

It should be understood that the supporting elements 14 may serve to reinforce the hanger bar 12. In the example illustrated, the overhanging portions are generally exposed and may carry the bulk of the
weight of the electrolytic cathode assembly 10 when in use in an electrolytic tank. The supporting elements 14 are arranged to distribute load from the overhanging portions to the rest of the hanger bar 12. The supporting elements 14 are also arranged to prevent bending, denting, etc., of the overhanging portions of the hanger bar 12, which are generally exposed beyond the lateral ends of a protective covering 34. By extending only partially between the ends of the hanger bar 12, the supporting elements 14 offer weight savings versus a supporting member that extends entirely between the ends of the hanger bar 12.

[0031] The supporting elements 14 may be manufactured from an electrically conductive material having a relatively high tensile strength. Corrosion resistance may not be necessary as the supporting elements 14 may generally not be exposed to corrosive fluid from the electrolytic bath and/or the cathode wash process. In some examples, the supporting element 14 may be manufactured from carbon steels, 300 series stainless steels, including, for example, 304 stainless steel, ferritic stainless steels, or duplex stainless steels. In some examples, the supporting element 14 may be manufactured at a thickness of 16-gauge or more.

[0032] In the example illustrated, referring now to Figure 3, an outward end 28 of the supporting element 14 may be offset relative to an end cap 30, to define a thermal expansion gap 32. The end cap 30 may be provided to seal the ends of the hanger bar 12, and may be secured to the hanger bar 12 using interference fit, adhesive, welding, or a combination thereof.

[0033] Referring again to Figures 1 and 2, the electrolytic cathode assembly 10 further includes a deposition plate 16. The deposition plate 16 may be manufactured from an electrically conductive material having a relatively high tensile strength and good corrosion resistance. In some examples, the deposition plate 16 may be manufactured from Grade 316L stainless steel or other alloys with acceptable anticorrosion properties and with, for example, a "2B" finish. It will be understood that various finishes may be used depending upon the particular application.
In the example illustrated, the deposition plate 16 includes the plate edges 18 and an upper edge 20 attached to the hanger bar 12. In the example illustrated, the plate edges 18 are mostly covered by edge strips 46, which may generally inhibit the deposition of copper or other desired metal occurring along the plate edges 18.

The deposition plate 16 may be attached to the hanger bar 12 by providing a slot in the hanger bar 12, and then welding the deposition plate 16 to the hanger bar 12 (as indicated at 36 in Figure 4). Alternatively, the deposition plate 16 may be welded directly to the hanger bar 12 without a slot. As high currents may be present in use, and it may be desirable to avoid high current concentrations at individual locations, the deposition plate 16 may be welded to the hanger bar 12 along its length on one or both sides, either with continuous welds or with stitch welds. It will also be understood that while reference here is made to welding the deposition plate 16 to the hanger bar 12, as these may be formed from dissimilar materials, this could be characterized more as a braze than a true welding operation.

Openings 44 may be provided in the deposition plate 16 to facilitate lifting the electrolytic cathode assembly 10 out of the tank (not shown). Alternatively, other electrolytic cathode assemblies may be provided with lifting hooks.

With continued reference to Figures 1 and 2, the electrolytic cathode assembly 10 includes the protective covering 34, which is provided generally around the hanger bar 12. In the example illustrated, the protective covering 34 covers the weld 36 (Figure 4), and substantially encloses a joint defined by the upper edge 20 of the deposition plate 16 and the hanger bar 12. Longitudinal edges of the protective covering 34 come into abutment with the deposition plate 16 and may be welded thereto, as indicated at reference numeral 38 in Figure 4. The welds 38 may extend along the entire length of the longitudinal edges of the protective covering 34 where they contact the deposition plate 16. The protective covering 34 provides additional structural strength to the electrolytic cathode assembly 10, and may be formed from
material that is the same or similar as the deposition plate 16, for example but not limited to stainless steel or other alloys with acceptable anti-corrosion properties.

[0038] Referring now to Figure 3, at either end of the protective covering 34, it provides a lateral end or edge 40 that may extend beyond the plate edges 18 of the deposition plate 16. The lateral edges 40 then leave portions of the overhanging portions of the hanger bar 12 exposed, at either end of the hanger bar 12. Adjacent to the lateral edges 40, the longitudinal edges of the protective covering 34 may face one another directly; if necessary they may be further deformed or pressed so as to abut or be close to one another. Then, the welds 38 may be extended to close off these portions of the protective covering 34 (see Figure 11). Overall, the scheme is such as to ensure that, with respect to the protective covering 34 and the deposition plate 16, there is a continuous weld or seal and no opening is left for penetration of fluid, except generally at the lateral edges 40 of the protective covering 34.

[0039] Figures 6 to 10 illustrate a plurality of forming steps utilized in the fabrication of the protective covering 34. In some examples, the protective covering 34 may be formed using a plurality of die forming operations. In some examples, the protective covering 34 may be formed using a progression die, with bends carried out in stamping stages of relatively small increments.

[0040] In Figure 6, the protective covering 34 may begin as a sheet of material (e.g., stainless steel) that is bent or otherwise deformed to define a central portion 22, and bottom side walls 24, 26. The central portion 22 includes the lateral edge 40 (and the other lateral edge at the other end of the protective covering 34). The bottom side walls 24, 26 include longitudinal edges 52, 54, respectively, which extend generally between the lateral edge 40 and the other lateral edge (not shown). In Figure 7, a groove or depression has been formed in the central portion 22 and the bottom side walls 24, 26 to define a channel 42 that extends generally adjacent and parallel to the lateral edge 40. The channel 42 may be formed using one or more die operations. In the example illustrated,
an access port 48 has been drilled, punched, pierced or otherwise produced through the central portion 22, in registration with the channel 42.

[0041] Referring to Figures 8 to 10, the central portion 22 has been further bent or otherwise deformed to define a top side wall 56 and side walls 58, 60. The side walls 24, 26, 56, 58, 60 define a central cavity for receiving the hanger bar 12. Spacing between the side walls 58, 60 may be selected to ensure sufficient clearance for the hanger bar 12, and spacing between the longitudinal edges 52, 54 may be selected to ensure sufficient clearance for the deposition plate 16, so as to enable sliding fit of the protective covering 34 over the assembly of the hanger bar 12 and the deposition plate 16.

[0042] When in position relative to the hanger bar 12 and the deposition plate 16, the side walls 58, 60 may be bent further to engage the hanger bar 12 so that the protective covering 34 is provided closely around the hanger bar 12. The welds 38 may then be completed (Figure 4). Also, as mentioned above, the longitudinal edges 52, 54 of the protective covering 34 adjacent to the lateral edge 40 may be further deformed or pressed so as to abut or be close to one another and the welds 38 may be extended to close off these portions of the protective covering 34 (shown in Figure 11).

[0043] Referring to Figure 11, the protective covering 34 may be provided closely around the hanger bar 12, but it may not be so tight as to prevent fluid penetration. Corrosive fluid from the electrolytic bath and/or the cathode wash process may potentially penetrate between the protective covering 34 and the hanger bar 12, generally at the lateral edges 40 of the protective covering 34.

[0044] At either end of the protective covering 34, the channel 42 may be injected with a corrosion resistant material. The material provides a seal between the protective covering 34 and the hanger bar 12 to at least hinder fluid flow into the protective covering 34, and is effective to prevent the possibility of corrosion between the protective covering 34 and the hanger bar 12.
The term "corrosion resistant material" as used herein generally refers to a material that is at least resistant to corrosion by liquids used in an electrolytic bath and a cathode wash to which the cathode assembly is exposed in use. The material may also be resistant to elevated temperatures, for example up to approximately 500°F or more, which portions of the electrolytic cathode assembly 10 may experience (e.g., in short circuit scenarios). The material may also be flowable, with the ability to flow within the channel 42 to extend about the hanger bar 12. The material is usually non-metallic, and is generally non-conductive. In some examples, the material may be polymeric. In some examples, the material may be a thermosetting plastic. In some particular examples, the material may be, for example but not limited to, a two-part epoxy.

As illustrated best in Figure 12, the channel 42 may extend generally around an entire periphery of the hanger bar 12 so that the corrosion resistant material, indicated at reference numeral 50, may provide a substantially continuous seal between the protective covering 34 and the hanger bar 12. In this manner, the corrosion resistant material 50 may form a fluid seal that would prevent, or at least hinder or significantly reduce, fluid ingress into any space between the protective covering 34 and the hanger bar 12, thereby to reduce the possibility of fluid reaching the weld 36 (Figure 4) between the deposition plate 16 and hanger bar 12 that may be subject to corrosion.

In some examples, the corrosion resistant material may be injected into the channel 42 through the access port 48. The access port 48 may extend through the protective covering 34 and enable fluid communication with the channel 42 externally of the protective covering 34. The corrosion resistant material may be delivered into the channel 42, through the access port 48, in fluid form and allowed to dry or otherwise cure. In the example illustrated, the access port 48 is arranged along the top side wall 56 of the protective covering 34. With this arrangement, the corrosion resistant material may be distributed through the access port 48 generally uniformly through
opposing sides of the channel 42, until the corrosion resistant material emerges from the channel 42 at the edges 52, 54 of the side walls 24, 26. In other examples the access port 48 may be arranged at another part of the protective covering. In some examples, the access port 48 may be omitted entirely, and the corrosion resistant material may, for example, be directly injected into the channel 42 at the edges 52, 54 of the side walls 24, 26. Various configurations are possible.

[0048] Referring now to Figure 13, there is shown an electrolytic cell arrangement indicated generally at reference numeral 100. Here, anodes 102 and cathodes 104 are suspended in a tank 106. Generally similar arrangements are used for electro-winning and electro-refining. For electro-winning, a solution is provided which the desired metal, e.g., copper, is in a solution. Electrolysis is then used to cause the copper or the desired metal to deposit on the cathodes. In electro-refining, metal already recovered, e.g., again copper, is provided as the anode, and by way of electrolysis is caused to go into solution and then deposit on the cathodes; the electro-refining operation has conditions set to encourage deposition of the desired copper on the cathodes, while leaving other undesired metals and other materials in solution, or otherwise not deposited on the cathodes.

[0049] Here, the anodes 102 and the cathodes 104 are indicated. Connections to a power source (not shown) are indicated at 118. The electrolytic solution or bath would be chosen to be suitable for the particular operation, e.g., electro-winning or electro-refining, and would be maintained at desired temperatures, etc.

[0050] While the above description provides examples of one or more apparatuses or methods, it will be appreciated that other apparatuses or methods may be within the scope of the accompanying claims.
We claim:

1. A method of manufacturing an electrolytic cathode assembly comprising:
   - attaching a deposition plate along an upper end to an electrically conductive hanger bar to define a joint;
   - forming a protective covering comprising a lateral edge;
   - arranging the protective covering to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint; and
   - injecting a corrosion resistant material into a channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar, thereby to at least hinder fluid flow into the protective covering at the lateral edge.

2. The method of claim 1, wherein the step of forming comprises forming the channel in the protective covering generally adjacent to the lateral edge.

3. The method of claim 2, wherein the step of forming comprises forming the protective covering from a sheet of material.

4. The method of claim 3, wherein the step of forming comprises bending the sheet of material to form sidewalls that define a central cavity for receiving the hanger bar.

5. The method of claim 4, wherein the step of forming comprises bending the sheet of material so that the sidewalls of the protective covering are spaced apart to receive the hanger bar in sliding fit.

6. The method of claim 5, wherein the step of arranging comprises bending the sidewalls to generally engage the hanger bar.
7. The method of any one of claims 3 to 6, wherein the step of forming comprises bending the sheet of material so that longitudinal edges of the protective covering are spaced apart to receive the deposition plate in sliding fit.

8. The method of claim 7, wherein the step of arranging comprises welding the longitudinal edges to the deposition plate.

9. The method of any one of claims 1 to 8, wherein the step of injecting comprises injecting the corrosion resistant material into at least one access port in fluid communication with the channel.

10. The method of claim 9, wherein the step of forming comprises forming the at least one access port in the protective covering.

11. The method of claim 10, wherein the step of forming comprises forming the at least one access port in a top side wall of the protective covering in registration with the channel.

12. The method of any one of claims 1 to 11, further comprising disposing at least one supporting element internally within the hanger bar.

13. The method of any one of claims 1 to 12, further comprising attaching the deposition plate to the hanger bar by at least one weld, and attaching the protective covering to the deposition plate by at least one weld.

14. The method of any one of claims 1 to 13, wherein the corrosion resistant material comprises an epoxy.

15. The method of any one of claims 1 to 14, further comprising forming the deposition plate and protective covering from stainless steel.

16. The method of any one of claims 1 to 15, further comprising forming the hanger bar from copper.
17. An electrolytic cathode assembly manufactured according to the method of any one of claims 1 to 16.

18. An electrolytic cathode assembly, comprising:
   an electrically conductive hanger bar;
   a deposition plate attached along an upper end to the hanger bar to define a joint;
   a protective covering comprising a lateral edge, the protective covering arranged to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint; and
   a corrosion resistant material disposed in a channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar, thereby to at least hinder fluid flow into the protective covering at the lateral edge.

19. The electrolytic cathode assembly of claim 18, wherein the channel is formed in the protective covering adjacent to the lateral edge.

20. The electrolytic cathode assembly of claim 19, further comprising at least one access port in fluid communication with the channel.

21. The electrolytic cathode assembly claim 20, wherein the at least one access port is formed in the protective covering.

22. The electrolytic cathode assembly claim 21, wherein the at least one access port is formed in a top side wall of the protective covering in registration with the channel.

23. The electrolytic cathode assembly of any one of claims 18 to 22, further comprising at least one supporting element disposed internally within the hanger bar.

24. The electrolytic cathode assembly of any one of claims 18 to 23, wherein the deposition plate is attached to the hanger bar by at least one weld, and the protective covering is attached to the deposition plate by at least one weld.
25. The electrolytic cathode assembly of any one of claims 18 to 24, wherein the corrosion resistant material comprises an epoxy.

26. The electrolytic cathode assembly of any one of claims 18 to 25, wherein the deposition plate and the protective covering are formed from stainless steel.

27. The electrolytic cathode assembly of any one of claims 18 to 26, wherein the hanger bar is formed from copper.

28. An electrolytic cell, comprising:
   - a tank containing an electrolytic bath;
   - an anode assembly contained within the electrolytic bath;
   - the cathode assembly of any one of claims 17 to 27 contained within the electrolytic bath; and
   - a power source electrically connected to the anode assembly and the cathode assembly to form the electrolytic cell.

29. A method of electro-refining or electro-winning a metal in an electrolytic cell, the method comprising:
   - providing a tank containing an electrolytic bath;
   - providing an anode assembly in the electrolytic bath;
   - providing the cathode assembly of any one of claims 17 to 27 in the electrolytic bath;
   - providing a power source;
   - electrically connecting the power source to the anode assembly and the cathode assembly to form the electrolytic cell; and
   - applying a sufficient amount of current to the electrolytic cell to cause metal ions from the electrolytic bath to be deposited onto a surface of the deposition plate of the cathode assembly.

30. A method of forming a protective covering for an electrolytic cathode assembly, the electrolytic cathode assembly comprising an electrically conductive hanger bar, and a deposition plate attached along an upper end to the hanger bar to define a joint, the method comprising:
providing at least one sheet of material; and
bending the sheet of material to form sidewalls that define a central cavity for receiving a hanger bar of the electrolytic cathode assembly,
wherein sidewalls of the protective covering are spaced apart to receive the hanger bar in sliding fit.

3.1. The method of claim 30, wherein the step of bending comprises at least one die forming operation.

3.2. The method of claim 30 or 3.1, further comprising arranging the sheet of material to generally surround the hanger bar and a portion of the upper end of the deposition plate so as to substantially enclose the joint.

3.3. The method of claim 3.2, wherein the step of arranging comprises bending the sidewalls of the sheet of material to generally engage the hanger bar.

3.4. The method of any one of claims 3.1 to 3.3, wherein the step of arranging comprises welding longitudinal edges of the sheet of material to the deposition plate.

3.5. The method of any one of claims 3.1 to 3.4, further comprising forming a channel in the sheet of material, and injecting a corrosion resistant material into the channel between the protective covering and the hanger bar to form a substantially continuous seal extending around the hanger bar.

3.6. The method of claim 3.5, wherein the step of forming comprises at least one die forming operation.

3.7. The method of claim 3.5 or 3.6, further comprising producing at least one access port in the sheet of material in fluid communication with the channel, and the step of injecting comprises injecting the corrosion resistant material into the at least one access port.
38. The method of claim 37, wherein the step of producing comprises at least one die forming operation.

39. An electrolytic cathode assembly or method of manufacturing an electrolytic cathode assembly comprising any combination of one or more of the features described above and/or claimed above and/or illustrated in the drawings.
A. CLASSIFICATION OF SUBJECT MATTER
   IPC: **C25C 7/02** (2006.01) , **C25C 1/00** (2006.01)
   According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
   Minimum documentation searched (classification system followed by classification symbols)
   IPC: C25C

   Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

   Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
   Canadian patent database, Epodoc, Scopus, Google.
   KW: cathode, hanger bar, joint, corrosion.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>CA 2697452 A1 (Tickling et al.) 5 March, 2009 (05-03-2009)</td>
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<td>A</td>
<td>US 5172850 (Prengaman et al.) 22 December, 1992 (22-12-1992)</td>
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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<td>document referring to an oral disclosure, use, exhibition or other means</td>
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<td>&quot;F&quot;</td>
<td>document published prior to the international filing date but later than the priority date claimed</td>
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| "Y" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| "X" | document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "Y" | document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "E" | document member of the same patent family |

Date of the actual completion of the international search 11 October 2013 (11-10-2013)
Date of mailing of the international search report 15 October 2013 (15-10-2013)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C1 14 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 001-819-953-2476

Authorized officer
Randall Menard (819) 997-2760
## INTERNATIONAL SEARCH REPORT

- **International application No.:** PCT/CA2013/05061

### Information on patent family members

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|                  |                  | MX2010001934A            | 09 August 2010   |
|                  |                  | PE08622009A1             | 15 July 2009     |
|                  |                  | US2009050488A1           | 26 February 2009 |
|                  |                  | WO2009026678A1           | 05 March 2009    |

| US5172850A       | 22 December 1992| None                     |                 |

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Form PCT/ISA/210 (patent family annex) (July 2009)