US 20180148852A1

(19) United States

(12) Patent Application Publication

Dufresne

(10) Pub. No.: US 2018/0148852 A1

(43) Pub. Date: May 31, 2018

(54) **ELECTROLYTIC VESSEL WITH REINFORCING COMPONENTS**

(71) Applicant: **Pultrusion Technique Inc.**, St-Bruno (CA)

(72) Inventor: **Robert Dufresne**, St-Bruno (CA)

(73) Assignee: **Pultrusion Technique Inc.**, St-Bruno, QC (CA)

(21) Appl. No.: **15/573,070**

(22) PCT Filed: **May 12, 2016**

(86) PCT No.: **PCT/CA2016/050542**

§ 371 (c)(1),
(2) Date: **Nov. 9, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/160,707, filed on May 13, 2015.

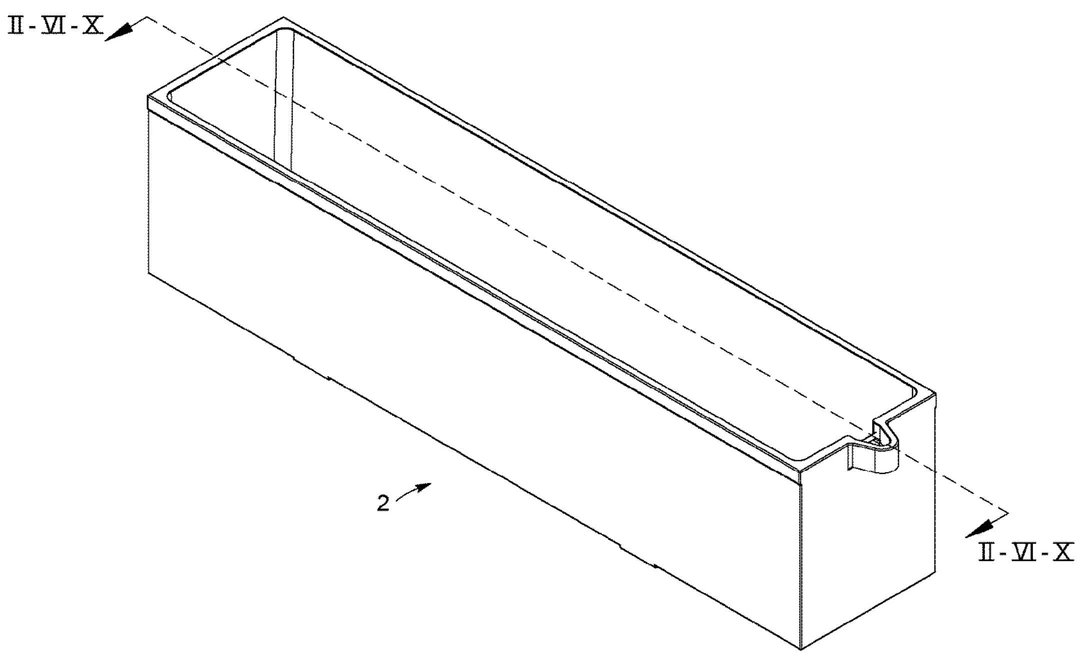
Publication Classification

(51) **Int. Cl.**
C25C 7/00 (2006.01)
C25C 1/00 (2006.01)

(52) **U.S. Cl.**
CPC . ***C25C 7/00*** (2013.01); ***C25C 1/00*** (2013.01)

(57) **ABSTRACT**

There is provided a product that generally relates to hydrometallurgical equipment and more particularly to a reinforced electrolytic vessel for refining non-ferrous metals. The vessel includes a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and at least two flat elongated pultruded fiberglass rebars embedded in each wall of the core.



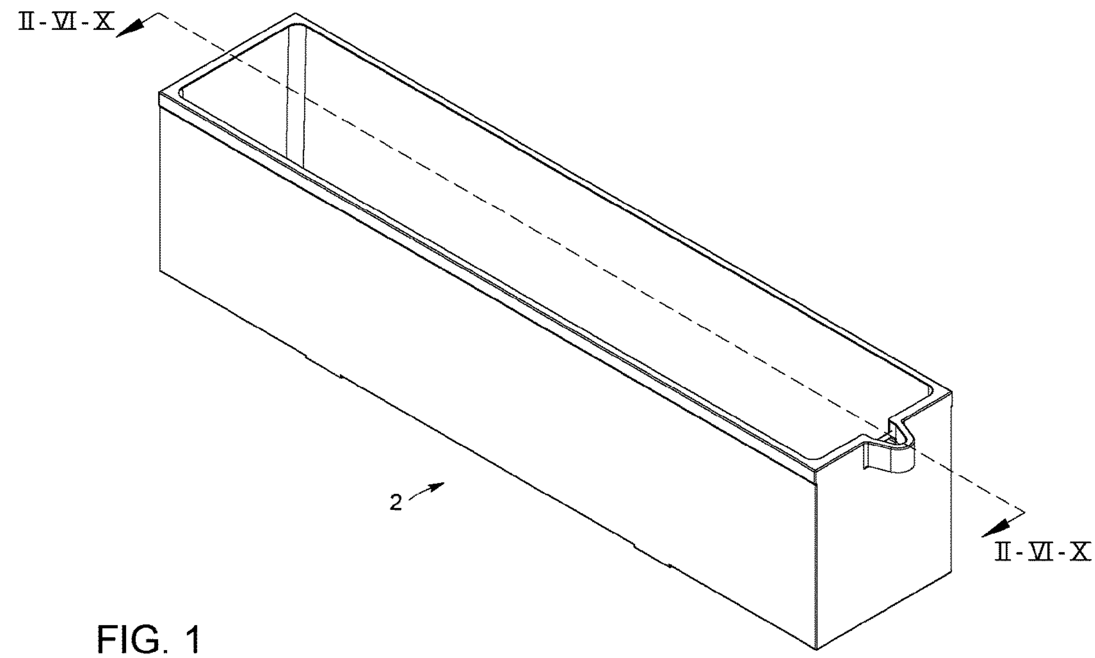


FIG. 1

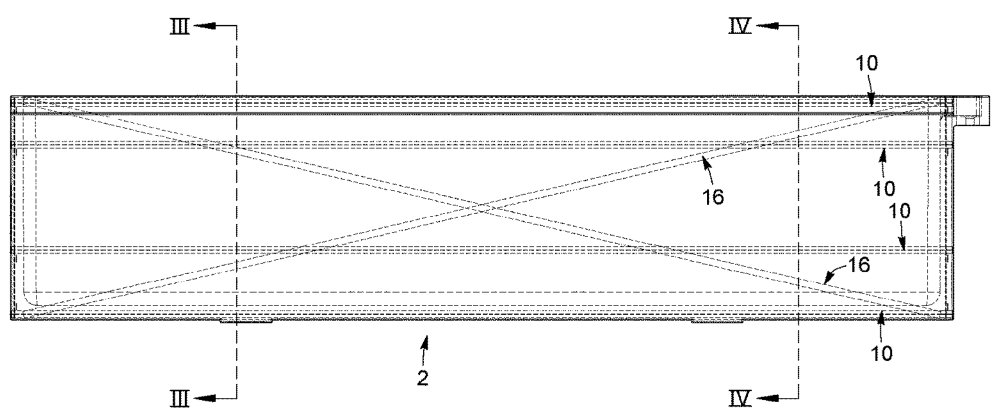


FIG. 2

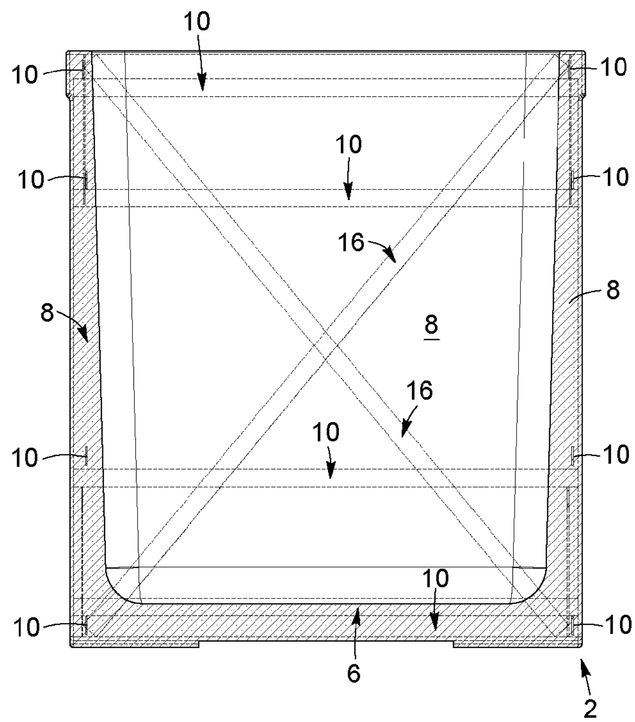


FIG. 3

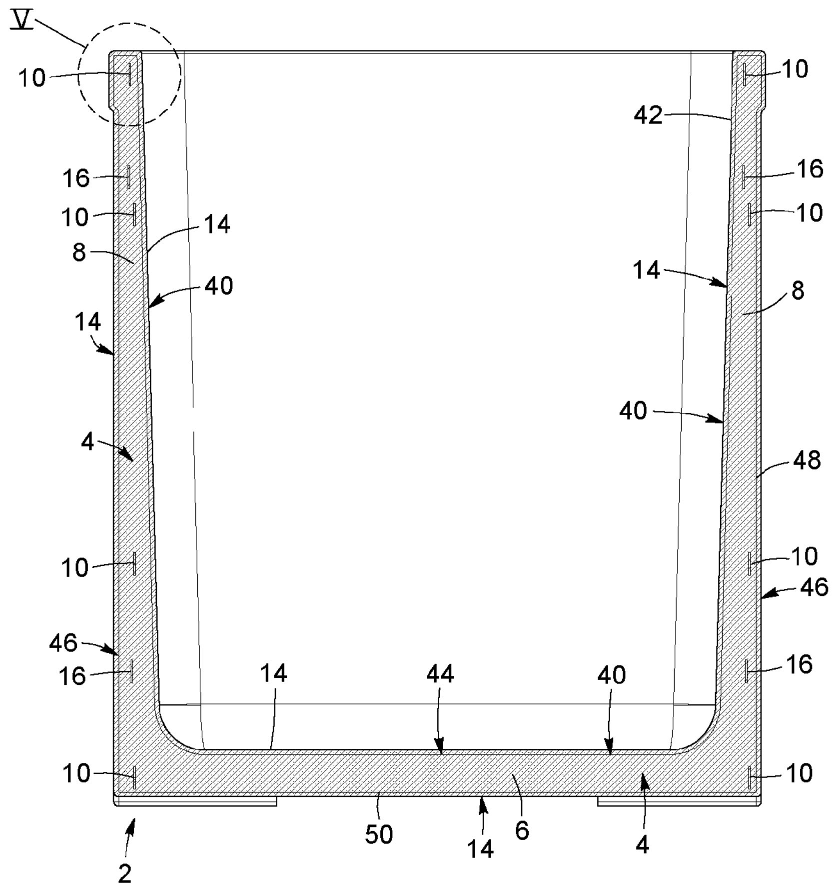

V
10
10
42
16
16
10
10
14
8
14
40
8
14
14
4
40
48
10
10
46
46
16
16
14
44
40
10
10
50
14
6
4
2

FIG. 4

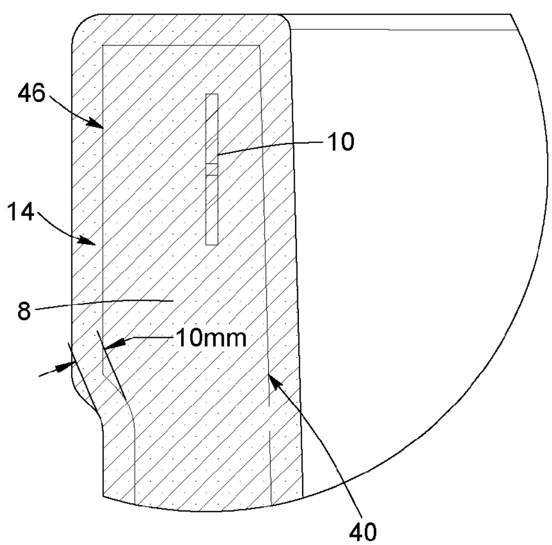


FIG. 5

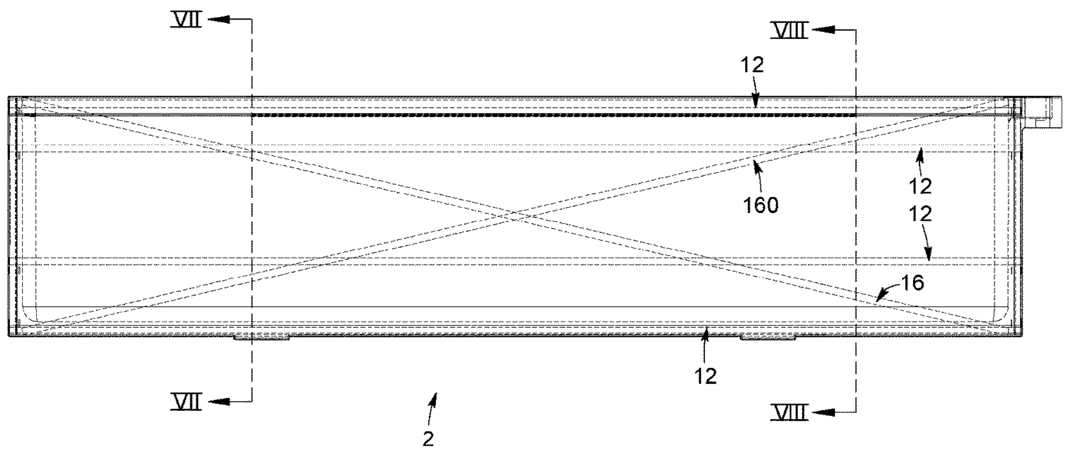


FIG. 6

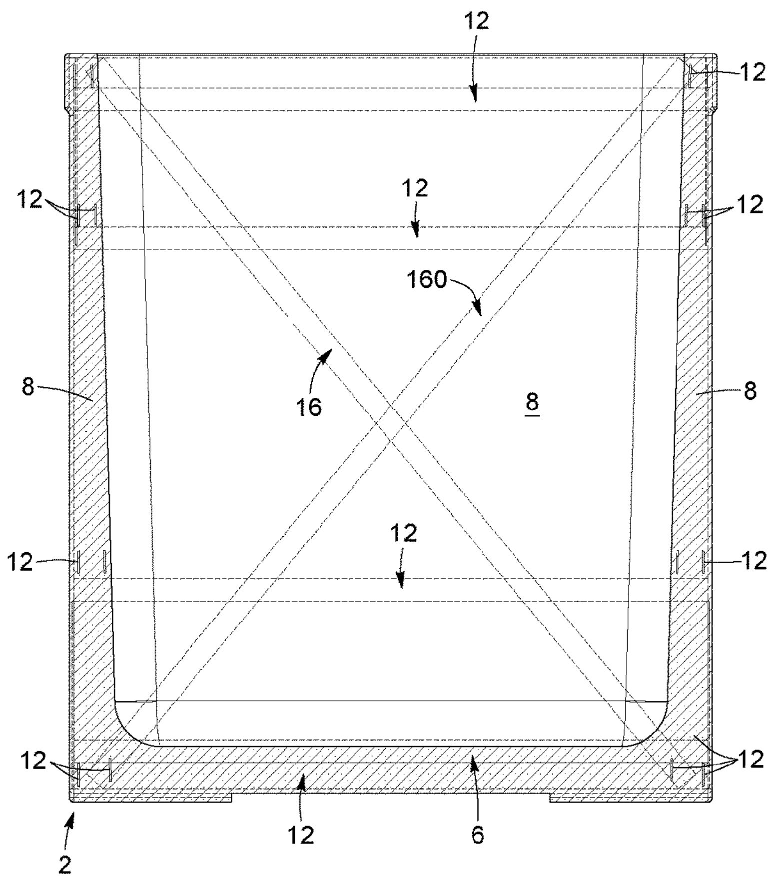


FIG. 7

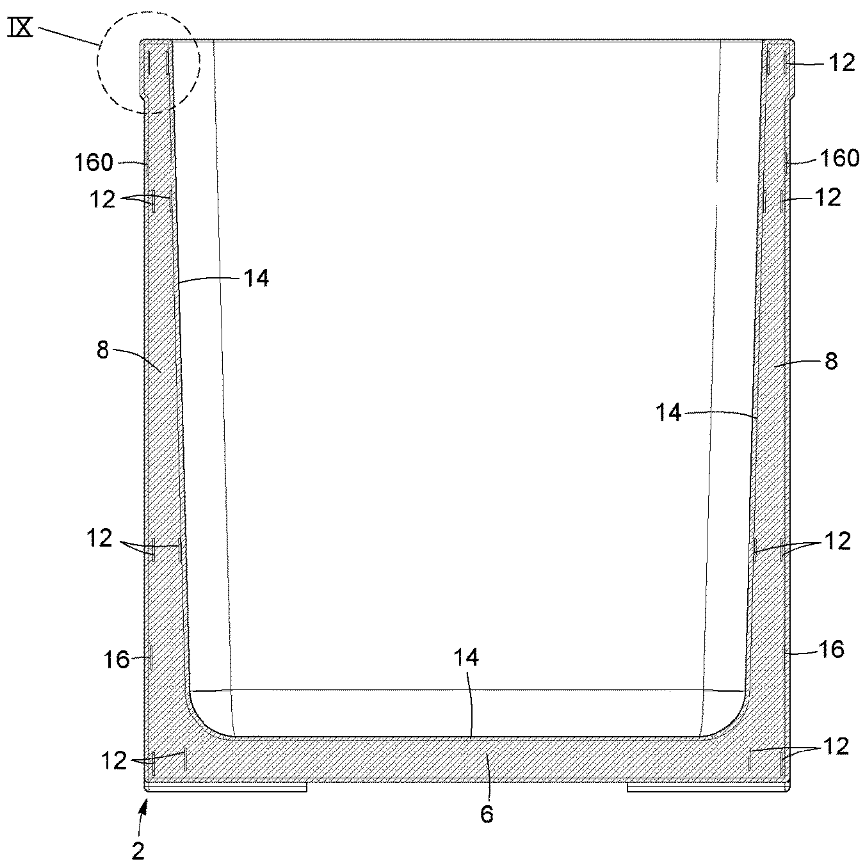


FIG. 8

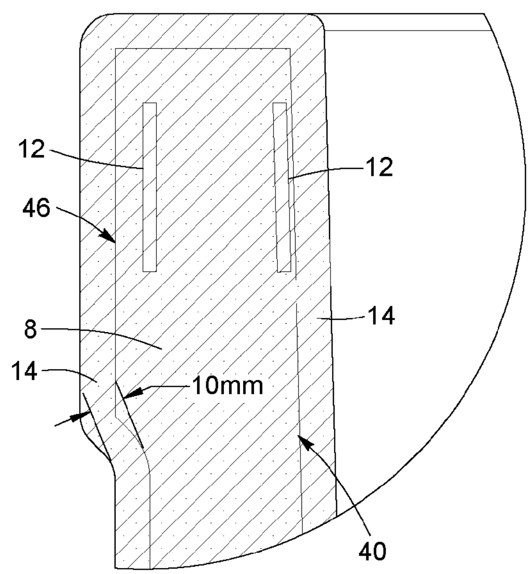


FIG. 9

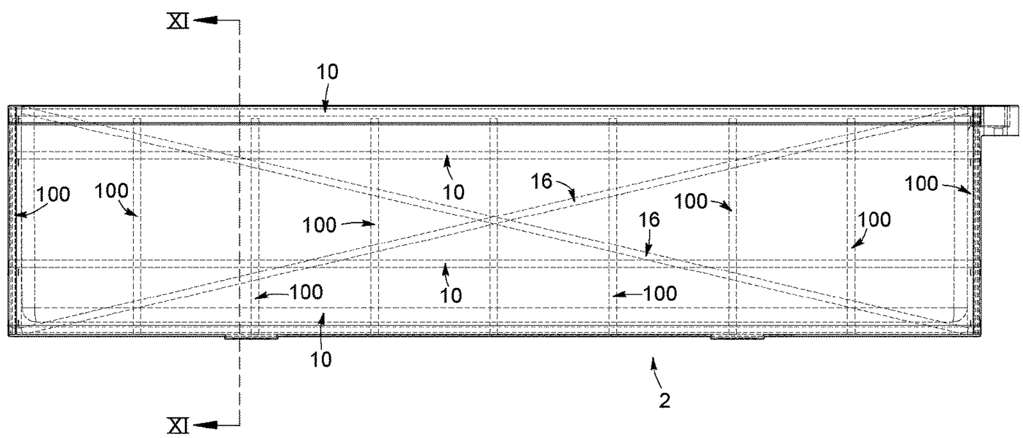


FIG. 10

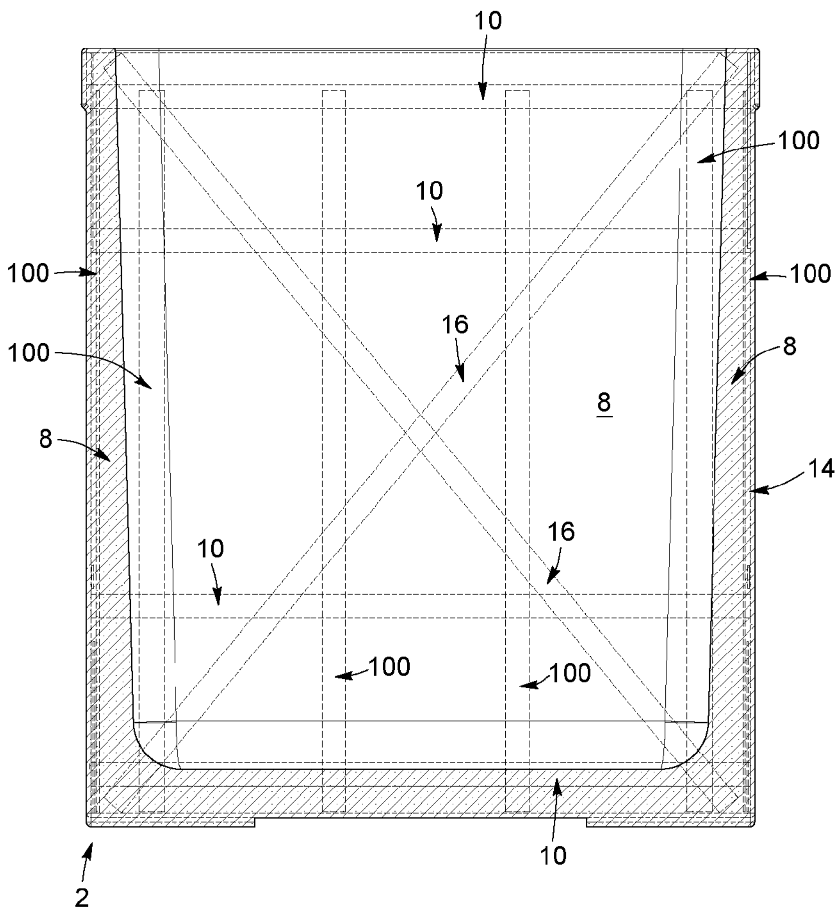


FIG. 11

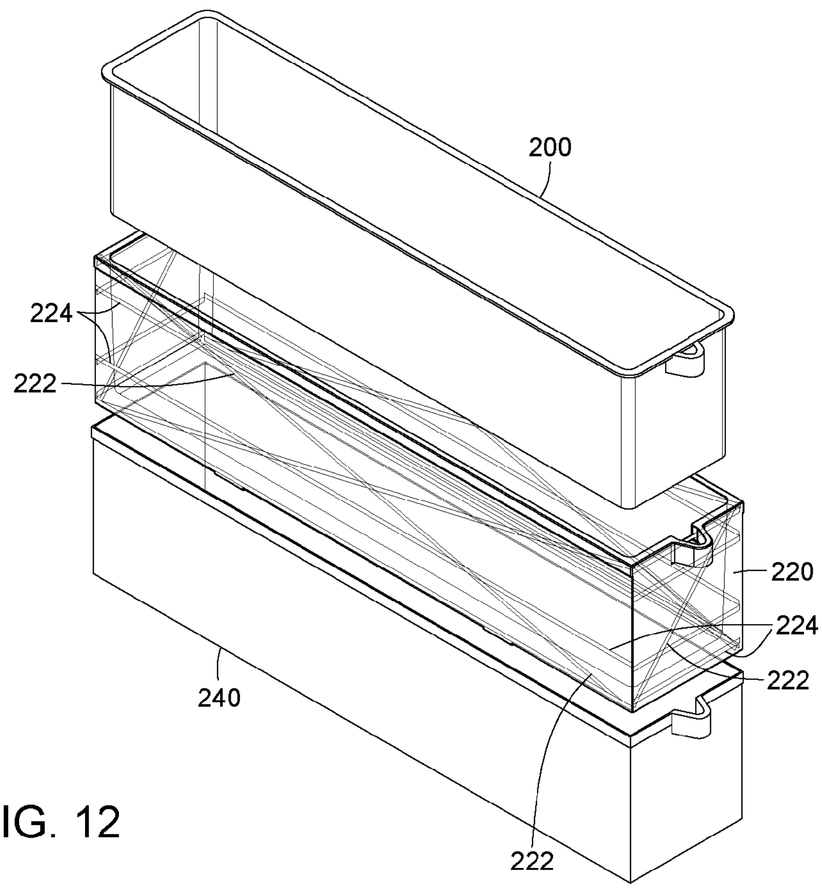


FIG. 12

ELECTROLYTIC VESSEL WITH REINFORCING COMPONENTS

TECHNICAL FIELD

[0001] The present product generally relates to hydrometallurgical equipment and more particularly to reinforced electrolytic vessels.

BACKGROUND

[0002] Hydrometallurgical processes make use of electrolytic vessels or tanks for refining non-ferrous metals (including copper, nickel, zinc, nickel, cobalt, manganese and other precious metals) with multiple rows of electrodes plunged in an acidic electrolytic bath contained in the electrolytic vessels. Materials of the electrolytic cells must therefore stand up to highly corrosive conditions and heavy weight of the electrodes and bath.

[0003] Known materials used for designing electrolytic vessels include steel reinforced concrete and composite material such as polymer concrete, or glass fiber and carbon fiber-reinforced corrosion-resistant polymers. However, concrete and polymer concrete vessel walls can crack due to the mechanical constraints imposed by the bath and electrodes and internal stresses while the concrete ages. In addition, unbonded or bonded surface liners can be used to cover the inner surface of the vessel. However, liners are prone to damage from impacts of electrodes and may also crack while aging, be altered by corrosion or suffer bad adhesion due to the curing during the casting process of the vessel, thereby enabling the corrosive bath to contact the unprotected walls of the vessel.

[0004] There is thus a need for an improved technology that can overcome at least some of the drawbacks of what is known in the field.

SUMMARY

[0005] In one aspect, there is provided a reinforced electrolytic vessel for refining non-ferrous metals. The vessel includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and at least two elongated fiberglass rebars embedded in each wall of the core.

[0006] In another aspect, there is provided a reinforced electrolytic vessel for refining non-ferrous metals which includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and a multiple-layer fiberglass-based envelope surrounding the core, the envelope comprising a fiberglass-based layer.

[0007] In another aspect, there is provided a reinforced electrolytic vessel for refining non-ferrous metals which includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; at least two flat elongated pultruded fiberglass rebars embedded in each wall of the core; and a multiple-layer fiberglass-based envelope surrounding the core, the envelope comprising a fiberglass-based layer.

[0008] In another aspect, there is provided a reinforced electrolytic vessel for refining non-ferrous metals which includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; a multiple-layer fiberglass-based envelope surrounding the core, the envelope comprising a fiberglass-based layer; and at least two elongated fiberglass rebars embedded in the multiple-layer fiberglass-based envelope.

[0009] In another aspect, there is provided a reinforced electrolytic vessel for refining non-ferrous metals which includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; a multiple-layer fiberglass-based envelope surrounding the core, the envelope comprising a continuous fiberglass-based layer; and a plurality of elongated pultruded fiberglass rebars embedded in each wall or the core, in the multiple-layer fiberglass-based envelope or in the combination thereof.

[0010] In another aspect, there is provided a reinforced electrolytic vessel for refining metals, such as non-ferrous metals, which includes: a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base, the core comprising a matrix comprising concrete and/or polymer material; and a plurality of elongated pultruded rebars embedded in the matrix and distributed there within to reduce cracking thereof, wherein the rebars are optionally provided as at least two rebars in each wall, as flat elongated rebars, as fiberglass rebars, as rebars arranged in spaced apart pairs, and/or as rebars having one or more features as described herein and/or as illustrated in the figures.

[0011] In another aspect, there is provided a method of reinforcing electrolytic vessel for refining metals, such as non-ferrous metals, which includes: providing a plurality of elongated pultruded rebars embedded in a matrix to form a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and the plurality of elongated rebars being distributed within the matrix to reduce cracking thereof, wherein the rebars are optionally provided as at least two rebars in each wall, as flat elongated rebars, as fiberglass rebars, as rebars arranged in spaced apart pairs, and/or as rebars having one or more features as described herein and/or as illustrated in the figures.

[0012] It should be understood that other aspects of the reinforced vessel are described hereinafter and may be combined with any other aspects described above. For example, depending on the tensile strength needed in each wall of the vessel, the vessel may include at least one flat elongated pultruded fiberglass rebar embedded in at least one wall of the core, at least a part of the multiple-layer fiberglass based envelope or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Embodiments of the electrolytic vessel and components thereof are represented in and will be further understood in connection with the following figures.

[0014] FIG. **1** is a perspective view of an electrolytic vessel used for refining non-ferrous metals.

[0015] FIG. **2** is a semi-transparent cross-sectional view along line II of FIG. **1** according to an embodiment of the reinforced vessel.

[0016] FIG. **3** is a semi-transparent cross-sectional view along line III of FIG. **2**.

[0017] FIG. **4** is a cross-sectional view along line IV of FIG. **2**.

[0018] FIG. **5** is a view of portion V of FIG. **4**.

[0019] FIG. **6** is a semi-transparent cross-sectional view along line VI of FIG. **1** according to another embodiment of the reinforced vessel.

[0020] FIG. **7** is a semi-transparent cross-sectional view along line VII of FIG. **6**.

[0021] FIG. **8** is a cross-sectional view along line VIII of FIG. **6**.

[0022] FIG. **9** is a view of portion IX of FIG. **8**.

[0023] FIG. **10** is a semi-transparent cross-sectional view along line X of FIG. **1** according to another embodiment of the reinforced vessel.

[0024] FIG. **11** is a semi-transparent cross-sectional view along line XI of FIG. **10**.

[0025] FIG. **12** is an exploded perspective view of the electrolytic vessel showing the inside hull made of fiberglass, with the semi-transparent inner core made of polymer concrete reinforced with embedded rebars, completed with an outer hull of fiberglass (i.e. envelope).

[0026] While the invention will be described in conjunction with example embodiments, it will be understood that it is not intended to limit the scope of the invention to these embodiments. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included as defined in the present specification.

DETAILED DESCRIPTION

[0027] Embodiments illustrated in FIGS. **1** to **9** relate to a reinforced electrolytic vessel including a plurality of flat pultruded fiberglass rebars embedded in each wall of the vessel and a surrounding multiple-layer fiberglass-based envelope. Flat rebars can offer improved tensile strength when the vessel walls are subjected to internal and external stresses. The number and orientation of the embedded flat pultruded fiberglass rebars may vary and can be adapted according to certain configurations and materials of the vessel.

Core

[0028] Referring to FIGS. **1** and **4**, in some embodiments, a vessel **2** includes a core **4** having a rectangular base **6** and four walls **8** extending from peripheral edges of the core base **6**. The core defines a cavity in which an electrolytic liquid or bath can be received. Optionally, the core may be made of polymer concrete or prestressed polymer concrete. The vessel **2** further comprises a plurality of flat pultruded rebars **10** that may be embedded within each of the four core walls **8**.

Rebars

[0029] It should be understood that the pultruded rebars of the reinforced vessel are flat in the sense that their cross-section in a transverse direction is inferior to their cross-section in a longitudinal direction. It should be understood that the size and shape of each of the at least two pultruded rebars of a same wall may be different from one rebar to the other rebar. Flat pultruded rebars can offer an increased contact surface with the core (e.g. in comparison to circular rebars) which is available for bonding chemically or mechanically with the material of the core so as to provide enhanced tensile strength to the vessel wall.

[0030] According to an embodiment of the reinforced vessel, the plurality of flat pultruded rebars of a same vessel wall may include at least two flat rebars. Referring to FIGS. **3** and **4**, the plurality of flat pultruded rebars of a same wall **8** may include at least four horizontal flat rebars **10**, distributed along a height of the wall. Referring to FIGS. **7** and **8**, the plurality of pultruded rebars of a same wall may be optionally organized in pairs **12** of two opposed rebars spaced-apart from each other, which may be referred to as "doubled rebars" **12**.

[0031] According to an embodiment of the reinforced vessel, the plurality of flat pultruded rebars of a same vessel wall may include a flat horizontal rebar near the top of the wall and three (3) vertical rebars near the top of the wall. One of the vertical rebars is placed in the middle of the width of the wall and the two others are spaced apart near the outer and inner side of the wall as shown in FIG. **9**.

[0032] The space between the rebars of a pair **12** may depend for example on a thickness of the core wall **8**. It should be understood that the doubled flat pultruded rebars may be used in order to increase the moment of inertia in a transversal direction of the vessel.

[0033] It should be understood that the flat rebars can include fiberglass and can be pultruded according to known pultrusion techniques.

Envelope

[0034] According to another embodiment of the reinforced electrolytic vessel, the mechanical resistance of the vessel walls to internal and external stresses is further improved by the use of a multiple-layer fiberglass-based envelope **14** surrounding the vessel core **4**, as seen for example in FIGS. **4** and **5**. The envelope includes a continuous fiberglass-based layer.

[0035] Optionally, the multiple-layer fiberglass-based envelope includes multiple layers of at least one of fiberglass mat, knitted fiberglass, stitched, stitched-mat, knitted-mat and fiberglass woven roving. Optionally, the multiple-layer fiberglass-based envelope may include successive layers of fiberglass mat, knitted fiberglass, stitched, stitched-mat, knitted-mat and fiberglass woven roving. Further optionally, a maximum thickness of the multiple-layer fiberglass-based envelope may be between about 8 mm and about 12 mm, optionally 10 mm. It should be understood that the choice of fiberglass-based material for the envelope may depend for example on the desired orientation of the fibers.

[0036] Referring to FIG. **4**, it should be understood that an inner surface of the core **40** corresponds to the combination of an inner surface of the core walls **42** and a top surface of the core base **44**, which could be in contact with the electrodes and electrolytic bath without the presence of the envelope **14**. An outer surface of the core **46** corresponds to the combination of a remaining external surface of the core walls **48** and a bottom surface of the core base **50**.

[0037] Alternatively, it should be understood that an outer envelope (hull) can be thinner in terms of chemical protection or structural protection than the inner envelope (hull) which is in contact with acid.

[0038] It should be also understood that the continuous fiberglass-based layer refers to a layer including fiberglass layering continuously at least the inner surface of the core. For example, a continuous fiberglass woven roving layer included in the multiple-layer fiberglass-based envelope may result from the superposition of two one-piece fiberglass woven roving extending from one vessel wall to the opposed vessel wall.

[0039] According to optional embodiments of the reinforced electrolytic vessel, positioning of the flat rebars may be chosen according to the thickness of the wall **8**. For example, referring to FIGS. **5** and **9**, some flat rebars **10** or **12** may be positioned proximate to the inner surface of the core **40**. Alternatively, referring to FIG. **9**, other flat rebars **12** may be positioned proximate to the outer surface of the core **46**.

[0040] According to another embodiment not illustrated in the Figures, the flat pultruded rebars may be optionally centered with respect to the cross-section of the wall in a transversal direction and aligned with respect to one another so as to be substantially co-planar. It should be understood that other flat pultruded rebars may be additionally placed proximal to the surface of the wall. Each rebar of the plurality of flat pultruded rebars are elongated so as to be a one-piece rebar extending from one wall to the opposed contiguous wall.

[0041] According to another embodiment, a pair of crossed flat pultruded rebars may be embedded within each vessel wall, proximate to the outer surface of the core of each of the four vessel walls. Optionally, the crossed rebars may be embedded either within the core or within the multiple-layer fiberglass envelope.

[0042] Referring to FIGS. **2** and **4**, a pair of crossed rebars **16** may be embedded within the core **4** each of the four walls **8**, proximate to the outer surface **46** of the core. It should be understood that, depending on the position of the crossed rebars within the core, crossed rebars **16** may be in contact with other horizontal rebars **10** or **12**. Referring to FIGS. **6** and **8**, a pair of crossed rebars **16** and **160** may be embedded within core **4** each of the four walls **8**, proximate to the outer surface **46** of the core. Optionally, one rebar **16** may be embedded within the core **4** of the vessel and the other rebar **160** may be embedded within the multiple-layer envelope **14**, both proximate to the outer surface **46** of the core **4**.

[0043] It should be understood that additional horizontal, vertical or crossed pultruded rebars may be embedded within the core or within the multiple-layer fiberglass-based envelope so as to further strengthen the structure of the vessel.

[0044] Referring to FIGS. **10** and **11**, vertical elongated fiberglass pultruded rebars **100** may be embedded in each core wall **8**. Optionally, vertical rebars may also be embedded in the multiple-layer fiberglass based envelope **14**.

Chemical Protection

[0045] According to an optional embodiment, a layer of gel coat or other chemical protection layers or sheets may be present on the inner and outer surfaces of the core, or beneath the multiple-layer fiberglass-based envelope so as to reinforce the chemical bonding between the resin of the polymer concrete (core) and the fibers of the fiberglass-based envelope. The gel coat or other chemical protection layers or sheets can also offer an additional barrier against corrosion.

[0046] According to a particular embodiment, as shown in FIG. **12**, three layers are shown ready to be nested into one another. A first top envelope (**200**) made of fiberglass mat is ready to nest into the polymer-concrete core (**220**) reinforced with crossed rebars (**222**) and horizontal rebars (**224**) embedded within its walls. A bottom envelope layer (**240**) made of fiberglass mat is provided underneath and ready to receive the core.

Process

[0047] In a particular embodiment, the process of constructing the electrolytic vessel core is shown upside-down in FIG. **12**. The vessel is constructed with two hulls (i.e. envelopes) in composite fiberglass, one interior envelope and another exterior envelope. The inner envelope (**200**) is made of a multiplicity of fiberglass layers. While coating the inner hull, or after coating, the outside hull (**240**) is constructed of Fiberglas layers on the outer walls of the inner envelope, leaving a space therebetween to form a cavity. Then, the cavity created between the inner hull (**200**) and the outer hull (**240**) is filled with Fiberglas rebars (**222**, **224**) that are held with tools well known in the art (such as studs or pins), The cavity is then filled layer by layer with polymer concrete to create the core (**220**).

[0048] Particularly, the rebars' surface may be ground and properly chemically treated to provide covalent chemical adhesion between the polymer concrete resins and the pultruded rebars.

[0049] According to a particular embodiment, the first two innermost layers of the internal envelope are made of "gel coat" (such as pure resin with little chemical additives) to obtain optimal corrosion resistance (i.e. against sulfuric acid and/or Cl_2 and/or Cl^-, chlorine). These two layers are then baked or cured by heat or catalyst.

[0050] After the two gel coats, an anticorrosive fiberglass coat is added on the outer surface of the inner envelope, such as type A or Type C fiberglass, and then a further layer of synthetic fiber can be added (such as polyester), or vice versa. These layers are then baked or cured with chemical or metallic catalyst or by UV curing or infrared curing system. These layers are baked following standard heat temperature curing system.

[0051] Further layers of polymer concrete can then be poured on placed rebars, and the whole vessel is then cooked once more, from 40° C. to 125° C.

[0052] Then follows the addition of the outer envelope structural fiberglass layers with further cooking/baking/heating.

[0053] It should be understood that the reinforced vessel is not limited to include at least two rebars in each wall of the core as illustrated in the Figures but may include at least one rebar embedded in at least one wall of the core, optionally in at least two walls of the core, optionally in at least three walls of the core and further optionally in each wall of the core. It should be understood that the number, shape and orientation of the rebars may vary and can be chosen to fulfill specific strength requirements for the vessel.

1.-**43**. (canceled)

44. An electrolytic vessel for refining metals, the vessel comprising:

a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and at least two elongated rebars embedded in the core.

45. The vessel of claim **44**, wherein the rebars are embedded in at least a wall of the core.

46. The vessel of claim **44**, wherein the rebars are flat whereby their cross-section in a transverse direction is inferior to their cross-section in a longitudinal direction.

47. The vessel of claim **44**, wherein the rebars are made in fiberglass, are pultruded, are arranged in spaced apart pairs or a combination thereof.

48. The vessel of claim **44** wherein at least one rebar is positioned proximate to an inner surface of the core and/or proximate to an outer surface of the core.

49. The vessel of claim **44**, wherein the rebars are aligned with respect to one another so as to be substantially coplanar.

50. The vessel of claim **44**, wherein at least one rebar is in contact with another rebar.

51. The vessel of claim **44**, wherein the rebars are unitary and extend from one wall to an opposed contiguous wall.

52. The vessel of claim **51**, wherein a size and a shape of one rebar of a wall is different from size and a shape of another rebar of the same wall.

53. The vessel of claim **50**, wherein the rebars are arranged as at least two rebars in each wall.

54. The vessel of claim **50**, wherein the rebars of a same wall includes at least two horizontal rebars.

55. The vessel of claim **50**, wherein the rebars are distributed along a height of the wall.

56. The vessel of claim **50**, wherein at least one rebar is centered with respect to a cross-section of the wall in a transversal direction.

57. The vessel of claim **50**, wherein at least one rebar is placed proximal to a surface of the wall.

58. The electrolytic vessel of claim **44**, wherein the core comprises a matrix comprising concrete or polymer material or a mixture thereof.

59. The electrolytic vessel of claim **58**, comprising at least two elongated rebars embedded in the matrix.

60. The electrolytic vessel of claim **44**, further comprising:

a multiple-layer envelope surrounding the core, the envelope comprising at least one fiberglass-based layer.

61. An electrolytic vessel comprising:

a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base;

a multiple-layer fiberglass-based envelope surrounding the core, the envelope comprising a fiberglass-based layer;

and at least one additional horizontal or vertical pultruded rebar is embedded within the core or within the multiple-layer fiberglass-based envelope.

62. The vessel of claim **61**, further comprising a layer of gel coat or other chemical protection layers or sheets arranged on inner and outer surfaces of the core, or beneath the multiple-layer fiberglass-based envelope.

63. A reinforced electrolytic vessel for refining nonferrous metals, including:

a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base, the core comprising a matrix comprising concrete and/or polymer material; and

a plurality of elongated pultruded rebars embedded in the matrix and distributed therewithin to reduce cracking thereof, wherein the rebars are optionally provided as at least two rebars in each wall, as flat elongated rebars, as fiberglass rebars, as rebars arranged in spaced apart pairs, or mixtures thereof.

64. A method of reinforcing electrolytic vessel for refining metals, comprising the steps of:

providing a plurality of elongated pultruded rebars;

embedding the rebars in a matrix to form a core shaped to hold an electrolytic liquid, the core comprising a rectangular core base and four walls extending upwardly from peripheral edges of the core base; and

distributing the plurality of elongated pultruded rebars within the matrix to reduce cracking thereof;

wherein the rebars are optionally provided as: at least two rebars in each wall, flat elongated rebars, fiberglass rebars, rebars arranged in spaced apart pairs, crossed rebars, or mixtures thereof.

* * * * *