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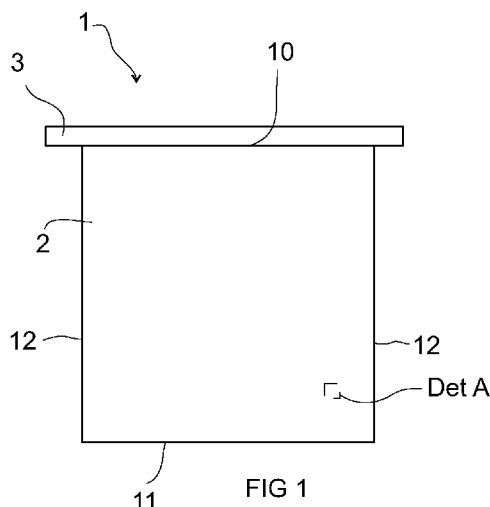
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(54) Title: ELECTRODE FOR AN ELECTROLYTIC PROCESS AND THE USE OF AN ELECTRODE



(57) Abstract: The invention relates to an electrode and the use of an electrode for an electrolytic process such as for a process for electrowinning of metals, wherein the electrode comprises an electrode plate (2) having a first surface (4) on one side of the electrode plate (2) and a second surface (5) on the opposite side of the electrode plate (2). At least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with projections (6) and/or depressions (7).

Electrode for an electrolytic process and the use of an electrode

Field of the invention

The invention relates to an electrode for an electrolytic process such as for a process for electrowinning of metals as defined in the preamble of independent claim 1.

Electrolytic processes, for instance sulfate based electrowinning of metals such as copper, typically take place in an electrolytic cell that contains a number of anodes and a number of cathodes arranged in an alternating manner. In the sulfate-based electrowinning process, an anode made of lead alloy or an anode with an electrocatalytically active coating and a cathode made of stainless steel are immersed in an electrolyte bath containing a solution comprising e.g. copper sulfate and sulfuric acid. An electrical current from the anode to the cathode induces an electro chemical reaction, wherein copper is deposited on the surface of the cathode. At the same time, oxygen gas and acid are generated on the anode. The oxygen generated forms very small bubbles on the anode surface. These bubbles subsequently rise to the surface of the electrolyte containing sulfuric acid, burst and release a fine aerosol or mist of electrolyte into the atmosphere above the electrolyte. This aerosol or mist, referred to as acid mist, typically has a similar composition as the electrolyte, i.e. it contains sulphuric acid and metal salts, and has a number of harmful side effects: it is hazardous to personnel working in the tankhouse and also causes corrosion when deposited on surfaces in the tankhouse. The acid mist is typically composed of liquid particles or droplets of approx. 1-100 μm in diameter in suspension.

Several techniques are available for reducing acid mist in electrowinning tankhouses. These include chemicals such as foaming agents or surfactants (e.g. FC-1100), mechanical barriers such as layers of hollow plastic spheres, polystyrene beads and the like, improved ventilation (e.g. cross-flow) and hoods and cell covers above the cells to remove and recover acid mist. One example of a tank cover apparatus for reducing acid mist is described in US 5470445. US 4668353 describes clips and masking devices that restrict the electrolyte surface area through which bubbles can pass into the atmosphere.

These techniques however have drawbacks and may be impractical to use. Hoods and cell covers are effective in removing acid mist, but they do not collect acid mist if not in place, for instance at the time cathodes are being harvested or in some plant practice when cell cleaning is carried out. Hoods and the associated scrubbing systems consume water and energy. Chemicals are an additional expense and they do not provide 100% reduction for acid mist. Further, it would be desirable to be able to reduce the amount of acid mist to a minimum.

Objective of the invention

The object of the invention is to provide an electrode, which electrode, when used in an electrolytic process, decreases the amount of acid mist produced in the electrolytic process.

Short description of the invention

The electrode of the invention is characterized by the definitions of independent claim 1.

Preferred embodiments of the electrode are defined in the dependent claims 2 to 16.

5 The invention is based on providing at least one of the first and the second surface of the electrode plate, preferably both the first and the second surface of the electrode plate, with projections and/or depressions for prolonging the residence time of the oxygen bubbles on the surface of the electrode plate and so allowing growth and or coalescence of the bubbles such that the amount of acid mist entering the tankhouse atmosphere is decreased.

10 The invention relates also to the use of the electrode in a process for electrowinning of metals to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

The invention relates also to the use of the electrode in a process for electrowinning of metals together with a hood at least partly covering the electrolytic cell in which said electrode is
15 used to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

The invention relates also to the electrode in a process for electrowinning of metals together with hollow spheres to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

20 The invention relates also to the electrode in a process for electrowinning of metals together with polystyrene beads to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

The invention relates also to the electrode in a process for electrowinning of metals together with anti-misting chemicals to reduce the amount of acid mist released into a tankhouse
25 atmosphere during the process for electrowinning of metals.

List of figures

In the following the invention will be described in more detail by referring to the figures of which

30 Figure 1 shows an electrode having an electrode plate,
Figure 2 shows the electrode shown in figure 1 as seen from one side,
Figure 3 shows a detail view of detail A in figure 1 according to a first embodiment,
Figure 4 shows a detail view of detail A in figure 1 according to a second embodiment,
Figure 5 shows a detail view of detail A in figure 1 according to a third embodiment,
35 Figure 6 shows a detail view of detail A in figure 1 according to a fourth embodiment,
Figure 7 shows a detail view of detail A in figure 1 according to a fifth embodiment,
Figure 8 shows a detail view of detail A in figure 1 according to a sixth embodiment,
Figure 9 shows a detail view of detail A in figure 1 according to a seventh

embodiment,

Figure 10 shows a detail view of detail A in figure 1 according to an eighth embodiment,

Figure 11 shows a detail view of detail A in figure 1 according to a ninth embodiment,

Figure 12 show use of an electrode plate in an electrolytic cell that is provided with a hood

Figure 13 shows an electrode having an electrode plate where one third of a first surface or of a second surface is provided with projections and/or depressions,

Figure 14 shows an electrode having an electrode plate where the half of a first surface or of a second surface is provided with projections and/or depressions, and

Figure 15 shows an electrode having an electrode plate where a first surface or a second surface is provided with three areas of projections and/or depressions.

Detailed description of the invention

Figures 1 and 2 shows an example of an electrode 1 for an electrolytic process such as a process for electrowinning of metals. Figures 3 to 11 show various embodiments of detail A in figure 1 (marked "Det A" in figure 1), i.e. different configurations of at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2.

The electrode 1 is preferably, but not necessarily, an anode for a process for electrowinning of metals such as copper.

The electrode comprises an electrode plate 2 having a first surface 4 on one side of the electrode plate 2 and a second surface 5 on the opposite side of the electrode plate 2. The height of the electrode plate 2 can for example be between about 1 m and about 1.2 m. The width of the electrode plate 2 can for example be between about 0.9 m and about 1 m. The thickness of the electrode plate 2 can for example be between about 6 mm and about 12 mm.

The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12.

The electrode is also provided with a hanger bar 3 or corresponding suspending arrangement for suspending the electrode in electrolyte (not shown in the figures) in an electrolytic cell (not shown in the figures) for performing the electrolytic process.

At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with projections 6 and/or depressions 7. Preferably, but not necessarily, both the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with projections 6 and/or depressions 7.

The projections 6 and/or depressions 7 are preferably, but not necessarily, at least partly formed by material of the electrode plate 2. It is for example possible that the projections 6 and/or the depressions 7 are formed at least in part by machining and/or plastically deforming at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2.

At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with projections 6 and/or depressions 7 by using a patterned

roller and by rolling at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 with such patterned roller. At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with projections 6 and/or depressions 7 by casting in a mould that is patterned.

5 It is also possible that the projections 6 and/or the depressions 7 are formed at least in part by adding material to at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2.

At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with grooves 8 so that projections 6 and/or depressions 7 are
10 formed as is shown in figures 3 to 11, especially in figure 3.

The grooves 8 may for example have a V-shaped, or U-shaped, semi-circular or trapezoidal cross-sectional profile.

At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with grooves 8 in the form of linear grooves 9 so that
15 projections 6 and/or depressions 7 are formed as is shown in figure 4.

At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may, as is shown in figures 5 to 11, be provided with grooves 8 in the form of essentially parallel first linear grooves 13 so that projections 6 and/or depressions 7 are formed.

20 The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12. At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with grooves 8 in the form of essentially parallel first linear grooves 13 so that the essentially parallel first linear grooves 13 extend perpendicularly with respect to the top edge 10 and to the bottom
25 edge 11 of the electrode plate 2 and parallel with respect to the two side edges 12 of the electrode plate 2 as is shown in figure 5.

The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12. At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with grooves
30 8 in the form of essentially parallel first linear grooves 13 so that the essentially parallel first linear grooves 13 extend parallel with respect to the top edge 10 and to the bottom edge 11 of the electrode plate 2 and perpendicularly with respect to the two side edges 12 of the electrode plate 2 as is shown in figure 6.

35 The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12. At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with grooves 8 in the form of essentially parallel first linear grooves 13 so that the essentially parallel first linear grooves 13 extend in an angular direction with respect to the top edge 10, to the bottom

edge 11 and to the two side edges 12 of the electrode plate 2 as is shown in figure 5. The angle between the essentially parallel first linear grooves 13 and the top edge 10, the bottom edge 11 and the two side edges 12 may be in the range of 65 to 25 degrees, preferably in the range of 60 to 30 degrees, for example 45 degrees.

5 If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8 in the form of provided essentially parallel first linear grooves 13, the distance between two adjacent essentially first parallel first linear grooves 13 may for example be between about 5 and about 50 mm, preferably between about 7 and about 15 mm, more preferably about 10 mm.

10 At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with a grooves 8 in the form of essentially parallel first linear grooves 13 and additionally with grooves 8 in the form of essentially parallel second linear grooves 14, which cuts the essentially parallel first linear grooves 13 so that projections 6 in the form of quadrilateral projections 15 are formed limited by two adjacent essentially parallel
15 first linear grooves 13 and by two adjacent essentially parallel second linear grooves 14 as is shown in figures 8 to 11.

The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12. At least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 may be provided with a
20 grooves 8 in the form of essentially parallel first linear grooves 13 and additionally with grooves 8 in the form of essentially parallel second linear grooves 14, which cuts the first set of essentially parallel first linear grooves 13 so that the essentially parallel first linear grooves 13 are parallel with the top edge 10 and the bottom edge 10 of the electrode plate 2 and so that the essentially parallel second linear grooves 14 are parallel with the two side edges 12 of the
25 electrode plate 2, as is shown in figure 8.

The electrode plate 2 has a rectangular or square shape so that the electrode plate 2 has a top edge 10, a bottom edge 11 and two side edges 12. If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8 in the form of provided essentially parallel first linear grooves 13 and essentially parallel
30 second linear grooves 14, the essentially parallel first linear grooves 13 may extend in an angular direction with respect to the top edge 10, to the bottom edge 11 and to the two side edges 12 of the electrode plate 2, and the essentially parallel second linear grooves 14 may extend in an angular direction with respect to the top edge 10, to the bottom edge 11 and to the two side edges 12 of the electrode plate 2 as is shown in figures 9 to 11. The angle between the
35 essentially parallel first linear grooves 13 and the top edge 10, the bottom edge 11 and the two side edges 12 may be in the range of 65 to 25 degrees, preferably in the range of 60 to 30 degrees, for example 45 degrees. The angle between the essentially parallel second linear grooves 14 and the top edge 10, the bottom edge 11 and the two side edges 12 may be in the

range of 65 to 25 degrees, preferably in the range of 60 to 30 degrees, for example 45 degrees.

If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8 in the form of provided essentially parallel first linear grooves 13 and essentially parallel second linear grooves 14, the distance between two adjacent essentially first parallel first linear grooves 13 may be between about 5 and about 50 mm, preferably between about 7 and about 15 mm, more preferably about 10 mm, and the distance between two adjacent essentially parallel second linear grooves 14 may be between about 5 and about 50 mm, preferably between about 7 and about 15 mm, more preferably about 10 mm.

If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8, the depth of the grooves 8 may be between about 1 and about 5 mm, preferably between about 2 and about 4 mm, more preferably about 2.5 mm.

If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8, the width of the grooves 8 may be between about 0.5 and about 5 mm, preferably between about 0.7 and about 2 mm, more preferably about 1.5 mm.

If at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with grooves 8, least one groove 8 extends preferably, but not necessarily, over the whole surface of the electrode plate 2.

The electrode plate 2 may be made of lead alloy.

It is possible that only part of at least one of the first surface 4 of the electrode plate 2 and the second surface 5 of the electrode plate 2 is provided with depressions 6 and/or depressions 7 as is shown in figures 13 to 15.

Figure 13 shows an electrode having an electrode plate 2 where one third of a first surface 4 or of a second surface 5 is provided with projections 6 and/or depressions 7 so that the upper part of the first surface 4 or of the second surface 5 is provided with projections 6 and/or depressions 7.

Figure 14 shows an electrode having an electrode plate 2 where the half of a first surface 4 or of a second surface 5 is provided with projections 6 and/or depressions 7 so that the upper part of the first surface 4 or of the second surface 5 is provided with projections 6 and/or depressions 7.

Figure 15 shows an electrode having an electrode plate 2 where a first surface 4 or a second surface 5 is provided with three areas of projections 6 and/or depressions 7 so that the areas span over the whole width of the surface of the electrode plate 2.

The invention relates also to the use of the electrode 1 in a process for electrowinning of metals to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

The invention relates also to the use of the electrode 1 in a process for electrowinning of metals together with a hood 16 at least partly covering the electrolytic cell 17 in which said

electrode is used to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

Similarly the patterned anodes may be used in combination with plastic spheres or polystyrene beads or foaming agents to decrease the mist present in the electrowinning
5 tankhouse atmosphere.

It is apparent to a person skilled in the art that as technology advanced, the basic idea of the invention can be implemented in various ways. The invention and its embodiments are therefore not restricted to the above examples, but they may vary within the scope of the claims.

Claims

1. An electrode for an electrolytic process such as for a process for electrowinning of metals, wherein the electrode comprises

an electrode plate (2) having a first surface (4) on one side of the electrode plate (2) and a second surface (5) on the opposite side of the electrode plate (2), and

a hanger bar (3) for suspending the electrode in electrolyte (not shown in the figures) in an electrolytic cell (17),

wherein by the electrode plate (2) having a rectangular or square shape so that the electrode plate (2) having a top edge (10), a bottom edge (11) and two side edges (12), **characterized**

by at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with projections (6) and/or depressions (7).

2. The electrode according to claim 1, **characterized** by the projections (6) and/or the depressions (7) at least partly formed by material of the electrode plate (2).

3. The electrode according to claim 1 or 2, **characterized** by at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with grooves (8; 9; 13; 14) so that projections (6) and/or depressions (7) are formed.

4. The electrode according to any of the claims 1 to 3, **characterized** by at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with grooves (8) in the form of linear grooves (9; 13; 14) so that projections (6) and/or depressions (7) are formed.

5. The electrode according to any of the claims 1 to 4, **characterized** by at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with grooves (8) in the form of essentially parallel first linear grooves (13) so that projections (6) and/or depressions (7) are formed.

6. The electrode according to claim 5, **characterized**

by the essentially parallel first linear grooves (13) being provided so that the essentially parallel first linear grooves (13) extend in an angular direction with respect to the top edge (10), to the bottom edge (11) and to the two side edges (12) of the electrode plate (2).

7. The electrode according to claim 5 or 6, **characterized** by the distance between two adjacent essentially first parallel first linear grooves (13) is between about 5 and about 50 mm, preferably between about 7 and about 15 mm, more preferably about 10 mm.

8. The electrode according to any of the claims 1 to 7, **characterized** by at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with a grooves (8) in the form of essentially parallel first linear grooves (13) and with grooves (8) in the form of essentially parallel second linear grooves (14), which cuts the essentially parallel first linear grooves (13) so that projections (6) in the form of quadrilateral projections (15) are formed limited by two adjacent essentially parallel first linear grooves (13) and two essentially parallel second linear grooves (14).

9. The electrode according to claim 8, **characterized** by the essentially parallel first linear grooves (13) extend in an angular direction with respect to the top edge (10), to the bottom edge (11) and to the two side edges (12) of the electrode plate (2), and

by the essentially parallel second linear grooves (14) extend in an angular direction with respect to the top edge (10), to the bottom edge (11) and to the two side edges (12) of the electrode plate (2).

10. The electrode according to claim 8 or 9, **characterized**

by the distance between two adjacent essentially parallel first linear grooves (13) is between about 5 and about 50 mm, preferably between about 7 and about 12 mm, more preferably about 10 mm, and.

by the distance between two adjacent essentially parallel second linear grooves (14) is between about 5 and about 50 mm, preferably between about 7 and about 12 mm, more preferably about 10 mm.

11. The electrode according to any of the claims 3 to 10, **characterized** by the depth of the grooves (8; 9; 13; 14) is between about 1 and about 5 mm, preferably between about 2 and about 4 mm, more preferable about 2.5 mm.

12. The electrode according to any of the claims 3 to 11, **characterized** by the width of the grooves (8; 9; 13; 14) is between about 0.5 and about 5 mm, preferably between about 0.7 and about 2 mm, more preferably about 1.5 mm.

13. The electrode according to any of the claims 3 to 12, **characterized** by the grooves (8) having a V-shaped, or U-shaped, semi-circular or trapezoidal cross-sectional profile.

14. The electrode according to claims 3 to 13, **characterized** by least one groove (8; 9; 13; 14) extend over the whole surface of the electrode plate (2).

15. The electrode according to claims 1 to 14, **characterized** by only a part or only parts of at least one of the first surface (4) of the electrode plate (2) and the second surface (5) of the electrode plate (2) being provided with projections (6) and/or depressions (7).

16. The electrode according to any of the claims 1 to 15, **characterized** by the electrode plate (2) being made of lead alloy.

17. Use of an electrode according to any of the claims 1 to 16 in a process for electrowinning of metals to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

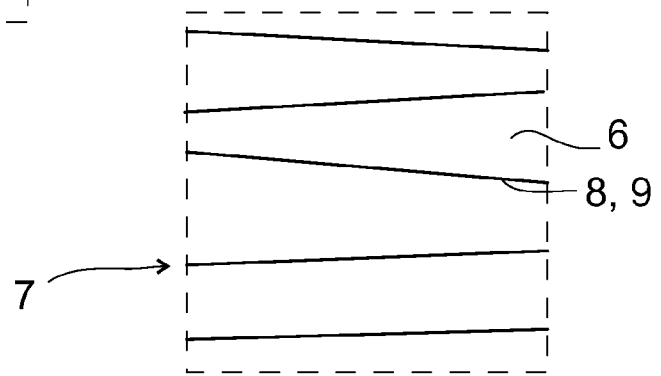
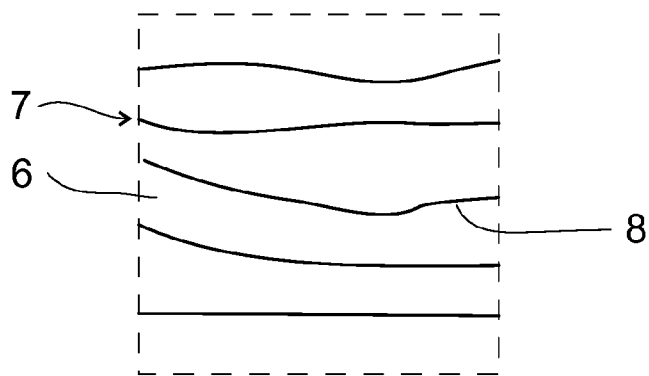
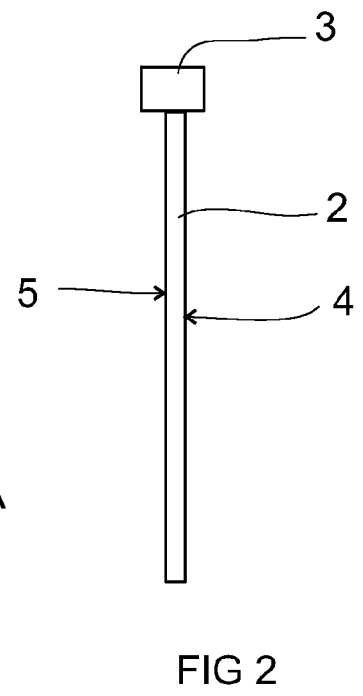
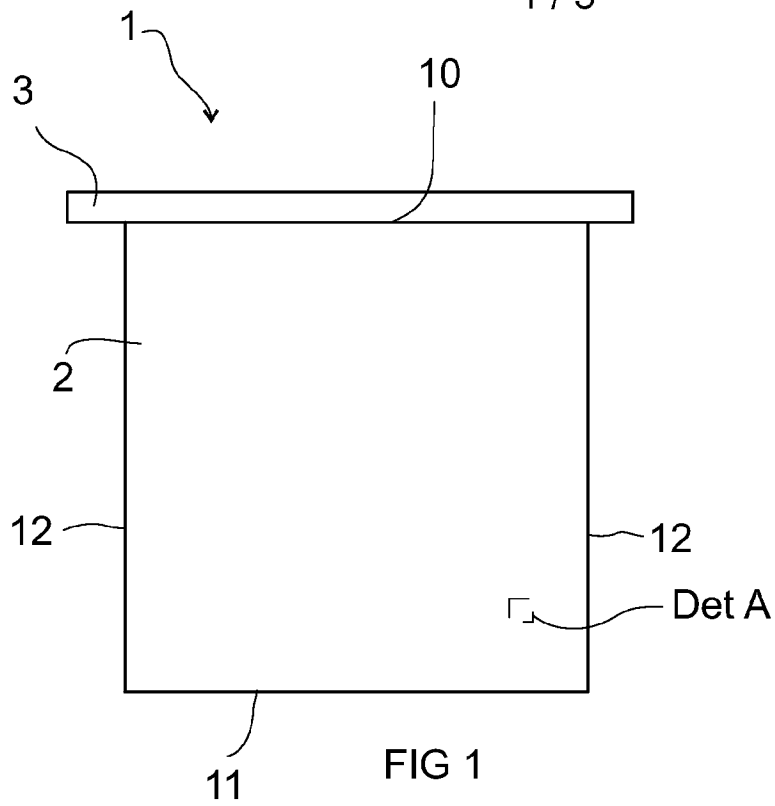
18. Use of an electrode according to any of the claims 1 to 16 in a process for electrowinning of metals together with a hood (16) at least partly covering the electrolytic cell (17) in which said electrode is used to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

19. Use of an electrode according to any of the claims 1 to 16 in a process for electrowinning of metals together with hollow spheres to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

20. Use of an electrode according to any of the claims 1 to 16 in a process for electrowinning of metals together with polystyrene beads to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

21. Use of an electrode according to any of the claims 1 to 16 in a process for electrowinning of metals together with anti-misting chemicals to reduce the amount of acid mist released into a tankhouse atmosphere during the process for electrowinning of metals.

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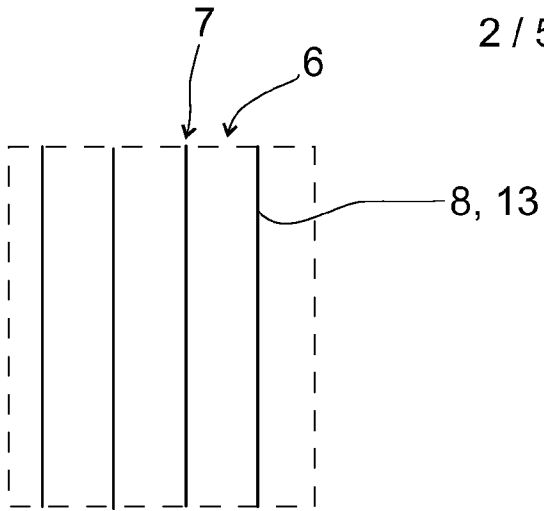


FIG 5

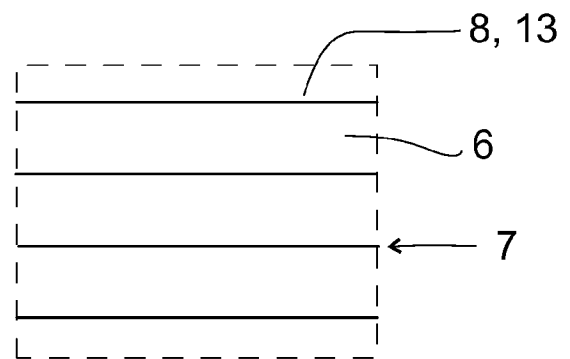


FIG 6

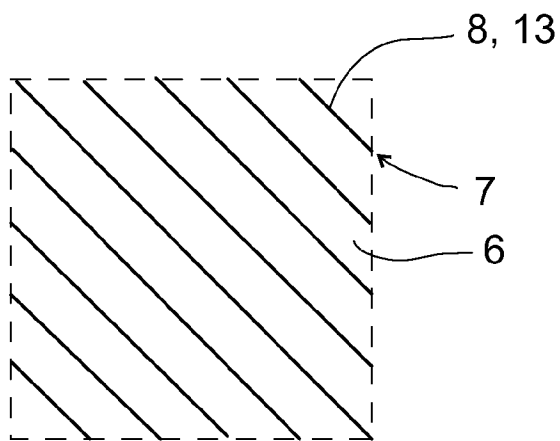


FIG 7

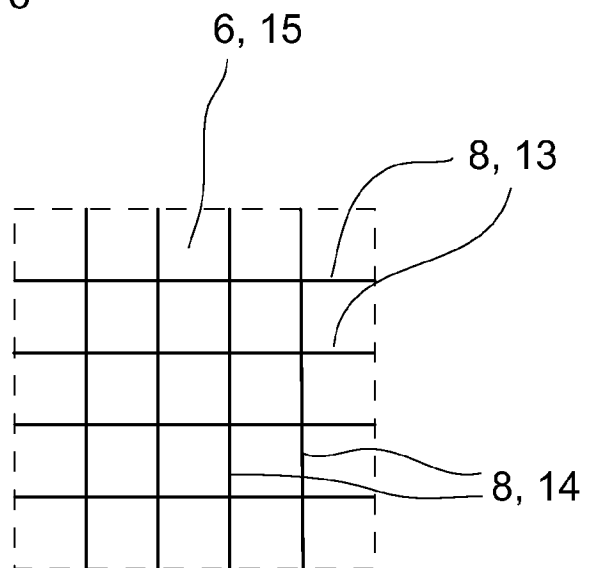


FIG 8

3 / 5

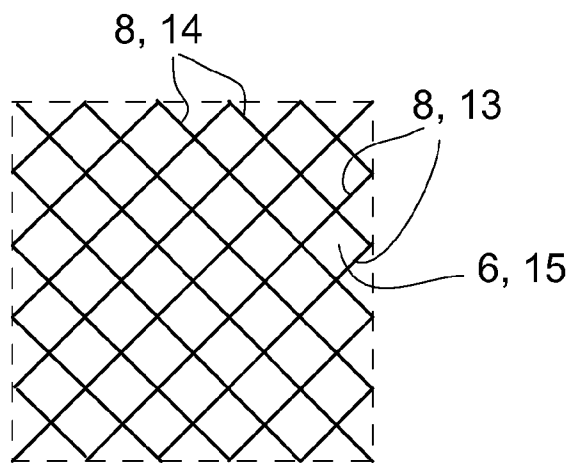


FIG 9

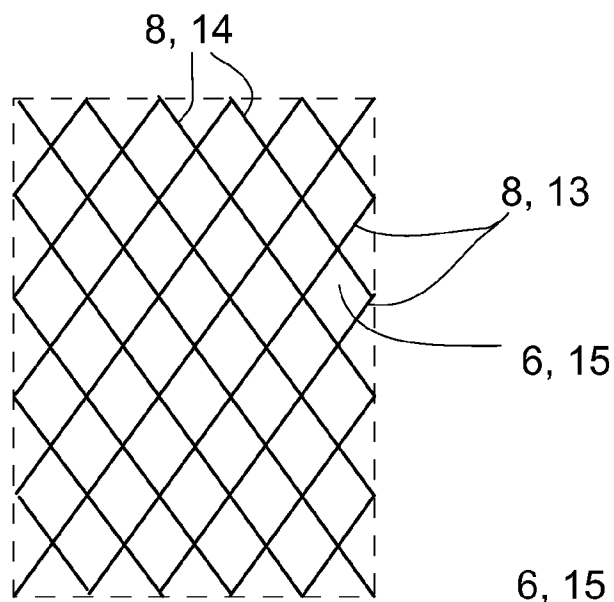


FIG 10

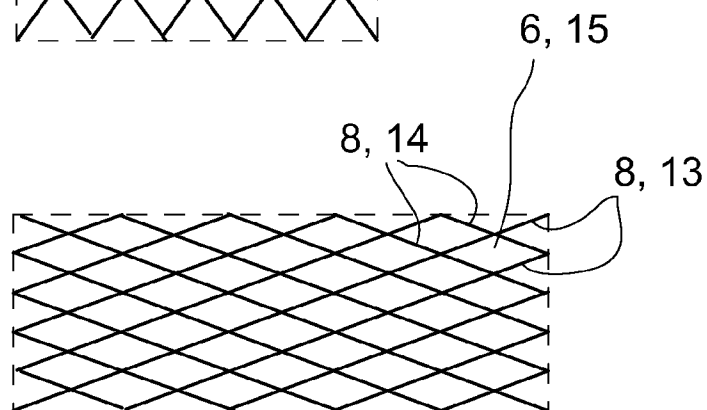


FIG 11

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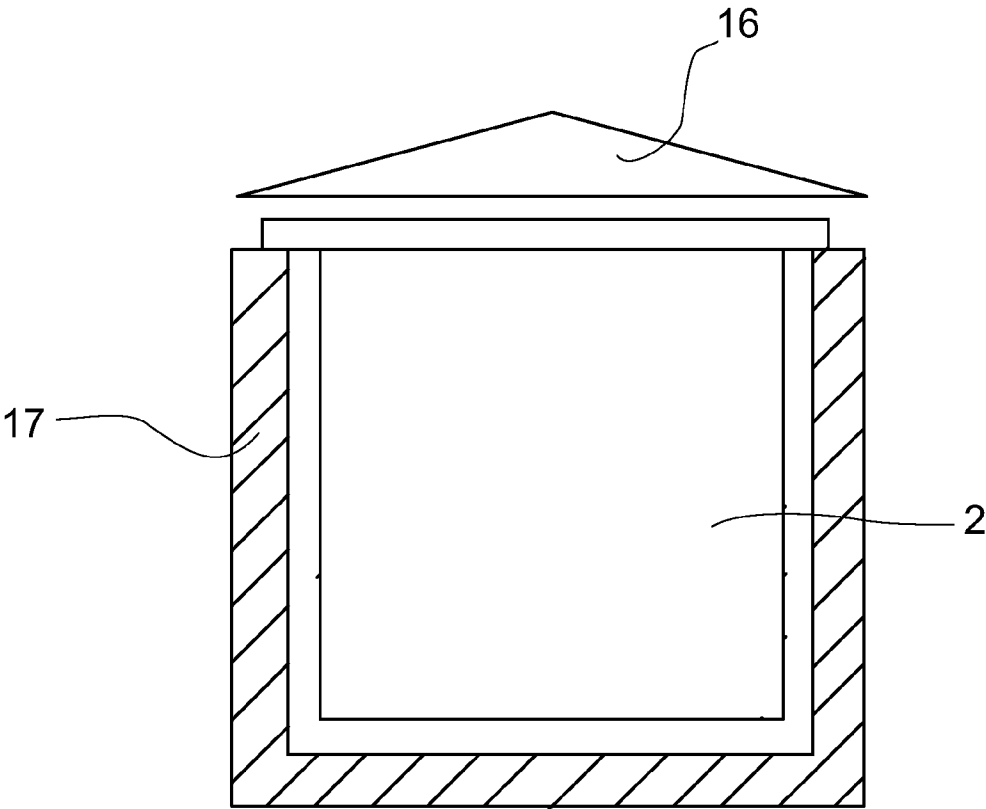


FIG 12

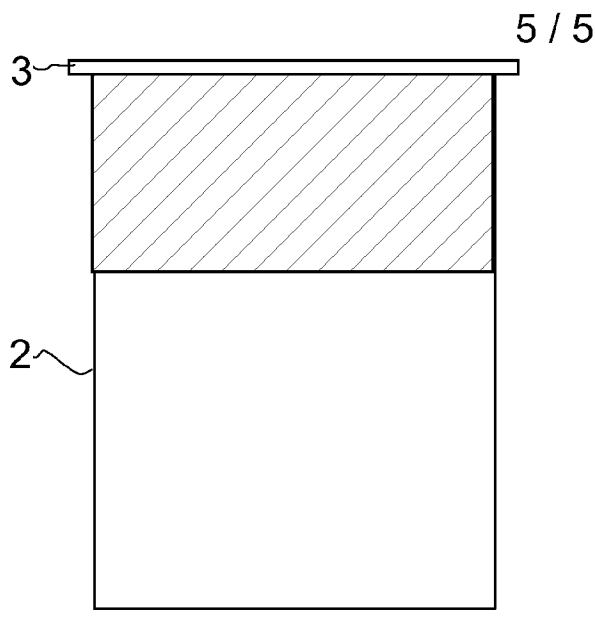


FIG 13

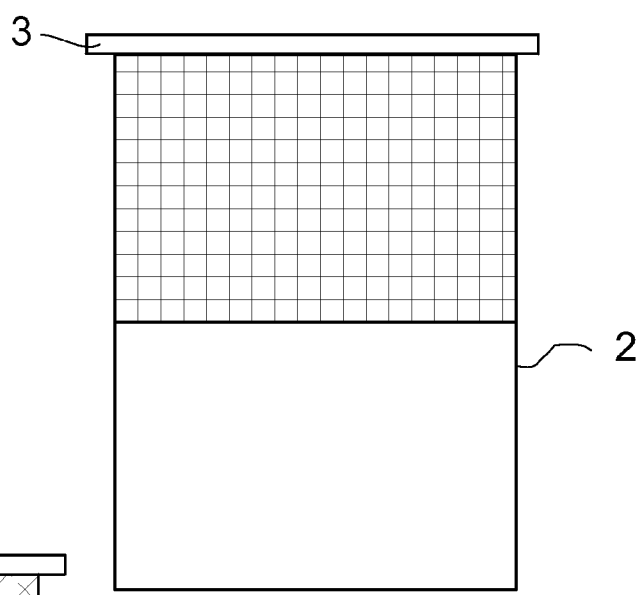


FIG 14

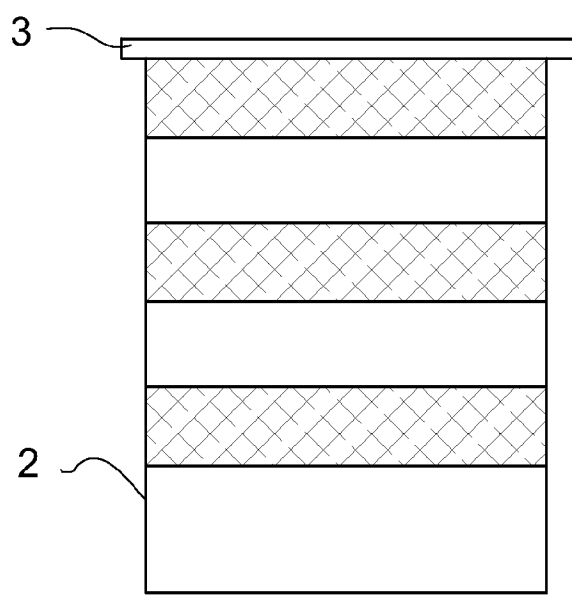


FIG 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2013/051162

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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
FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4699704 A (ISHIZUKA HIROSHI [JP]) 13 October 1987 (13.10.1987) column 1, lines 4-7; column 1, line 56 – column 2, line 41; column 2, line 64 – column 3, line 4; column 3, lines 8-14; column 3, lines 41-51; column 3, line 66 – column 4, line 4; column 4, line 59 – column 5, line 47; Fig. 1-3	1-5, 17 16, 18-21
X Y	WO 2008138945 A2 (INDUSTRIE DE NORA SPA [IT]) 20 November 2008 (20.11.2008) page 3, lines 22-25; page 5, lines 21-23; page 11, claims 1, 3, 4	1-15 16-21
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Y	US 2007193879 A1 (PRENGAMAN DAVID R [US] et al.) 23 August 2007 (23.08.2007) abstract; page 1, paragraph [0010]	16



Further documents are listed in the continuation of Box C.



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Int. Cl.

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