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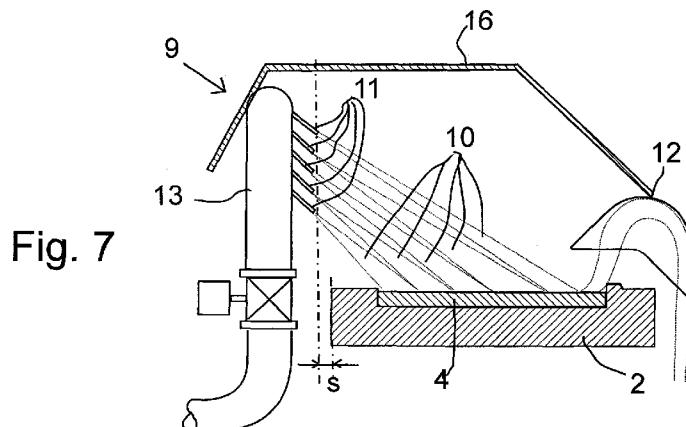
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(54) Title: METHOD AND EQUIPMENT FOR CASTING ANODES



(57) Abstract: The invention relates to a method and equipment for casting anodes. In the method, an anode (4) that is cast in a mould (2) is cooled at cooling stages, wherein water is sprayed on the top surface of the anode. The cooling stages include one or more power cooling stages, wherein water is sprayed on the top surface of the anode (4) by a power cooling device (9), at high pressure and with at least one water spray (10), which is directed obliquely at the anode top surface so that the water spray passes by the lifting lugs (7) of the anode and the edge zone (5) of the mould surrounding the lifting lugs without essentially touching them. The volume flow and the pressure of the water spray are selected so that the water spray penetrates the layer of steam that is possibly on the surface, gets into contact with the anode surface and bounces from the anode surface over the edge zones of the mould, from the opposite side of the edge zones of the mould, essentially without rinsing and cooling.

**METHOD AND EQUIPMENT FOR CASTING ANODES****FIELD OF THE INVENTION**

The invention relates to a method defined in the preamble of Claim 1. The invention further relates to anode casting equipment defined in the preamble of Claim 10.

**BACKGROUND OF THE INVENTION**

10 The invention relates to the manufacture of anode plates in the refining process of a metal, such as copper, which is carried out after conversion. A product is obtained from a flash smelting furnace, containing iron, sulphur and noble metals in addition to copper, 15 and iron and sulphur are removed in the conversion by means of oxygen-enriched air. The converter copper thus obtained is conveyed to an anode furnace, where it is further purified to remove the sulphur. The sulphur that possibly remains in the conversion in the anode 20 furnace is oxidized into sulphur dioxide by blowing air into the liquid metal. Then, oxygen is removed from the melt.

25 The molten copper of the anode furnace is cast into anode plates by the anode casting equipment, their copper content being about 99.5%. Typically, the size of the anode plate is about 1 m x 1 m, and its thickness is about 5 cm. The anode typically comprises lifting lugs, by which it can be lifted and suspended in a vertical 30 position for electrolysis. Typically, the anode weighs about 300-400 kg. The finished anode plates are then purified by electrolysis into copper cathodes, the copper content of which is 99.99%.

The type of presently known anode casting equipment that is used the most is the one, which includes a casting table that rotates around a vertical axis and contains a number of open moulds that are arranged in a circle. The casting table is rotated periodically, so that each move is followed by a stop of a specific duration.

In the anode casting equipment, copper is conveyed from the anode furnace along a launder to a casting machine, and further to the open moulds that are made of copper. The molten copper is prevented from sticking to the moulds by painting the moulds, at each cycle, with mould paint or a release agent, which can comprise, e.g., barium sulphate mixed with water. The casting comprises the following stages: casting, cooling, releasing from the mould, lifting into a cooling tank, and painting the mould.

The anode cast in the mould cannot be cooled before its surface is solid enough. Immediately after casting, the temperature of the molten anode in the mould is about 1150 °C (its melting point is 1084 °C), and it should normally be cooled in the mould to a temperature of 700-950 °C, where it has solidified enough to be detached from the mould.

When starting the casting, the temperature of the copper mould, in which the anode is cast, is not lower than about 60°C at the beginning of the casting and, generally, during three cycles of the casting table, it reaches a balance, where its inner temperature is about 200 °C and the surface temperature of the end face, measured in the middle outside the table, is about 150 °C. Now, the mould does not run too hot for its service life not to be too short. In that case, the water-

dilutable release agent that is sprayed on the mould surface after removing the anode also dries enough for no splinters to develop on the edges of the anode that is cast in the mould. If the release agent is sprayed 5 on the surface of an excessively cold mould, it has no time to dry before casting is started in the mould in question. It is essential for the entire cooling of the mould and the anode that the mould keeps its optimum temperatures, and anodes with sufficient quality for 10 the electrolysis can be cast.

The anode should be cooled so that it is sufficiently solid to be lifted out of the mould and into immersion cooling in a cooling tank, where the final cooling 15 takes place. On the other hand, excess cooling of the anode causes the anode to shrink in the mould, and a crack may develop between the lugs, making the anode useless. For the above reasons, the anode temperature is preferably 700-950 °C when lifted from the mould.

20 The known method and equipment comprise cooling the anodes in moulds with the casting table rotating, so that so-called full cone nozzles are arranged in several places on top of the mould path at the stopping positions of and above the anodes, cooling water being sprayed by them on the anode surface by conical sprays. On top of the cooling positions, there is a hood for collecting water vapour. Such upstream cooling positions that are directly focused on the anodes are provided in the area of the steam extractor hood at each 25 stopping position, starting from where the anode is solidified enough for the water spray directed at the anode not to cause sagging of the anode surface.

30 35 A water spray directly focused on the anode is a relatively effective way of removing heat from the anode.

By means of water spraying, the cooling capacity of the casting table can be adjusted during momentary changes in the casting capacity, so that the desired amount of heat can be removed from the anodes before 5 they are lifted into the cooling tank.

The amount of cooling water in the known anode casting equipment has been about 20-30 l/min for an anode per mould position and 210 l/min per mould, and the temperature of the mould is adjusted by shutting and opening them by the on/off principle, so that a suitable number is operating according to the casting circumstances. The upstream water control has been carried out manually by the program of the control room 10 15 by means of an operator.

Now and then, disturbances occur at the casting table, whereby no casting can be made in a mould but it is allowed to rotate for one or more casting cycles without casting. This is the case, for example, when the lifting pin of the anode in the mould remains elevated, and there is not time to put it down. The present cooling system is constructed so that the casting operator changes the state of the mould in the automation system, and the cooling is discontinued in the mould position, where a mould that is to be kept dry 20 25 has stopped.

Regarding the capacity and usability of the anode foundry, keeping the mould dry, as mentioned above, is 30 of a considerable significance. If an empty mould is sprayed, it may happen that the moulds gradually fall out of use and the casting is prolonged or even discontinued. Soaked moulds must be dried separately, for 35 example, by propane burners between castings.

The amount of upstream water that is sprayed directly on the anode by the prior art technology has had a maximum. The deliveries have comprised pipework and nozzles, wherein the amount of water has been increased as the capacities have increased. However, in practical implementation, it has been necessary to adjust the nozzle positions smaller or remove them entirely for different reasons.

10 The problem therefore is that, if an excessively large nozzle is used in cooling, the hollow in the anode is filled with boiling water. If water is added at the subsequent cooling position thereafter, it will not penetrate all the way to the anode surface, as the 15 isolating layer of water froth kills the spray. In that case, water only participates in preserving the layer of water froth.

Another problem is that, in practice, the upstream water that cools the anode cannot be increased by the present technology, thus limiting the capacity of the casting table. Generally, higher capacity means building a larger casting table that comprises more moulds and takes more space. It is not possible to automate 25 the upstream waters when the entire upstream water capacity is in use in the casting. Automation would need more cooling capacity in order to provide adjustment tolerance. At the moment, it has not been possible to adjust the temperature of the anode at top capacities, 30 in practice, since all the upstream cooling positions have been in operation.

When cooling with the conical upstream sprays, in other words, by one nozzle on top of the anode, water 35 exceeds the edges of the mould evenly at each spot, disadvantageously rinsing and cooling the edge zones

of the mould, including the lug areas of the mould. In the area of the anode's lifting lugs, the mould gets less heat as such, whereby the lugs cool to excess. Too cold lug areas of the mould cause splinters in the 5 anode lugs, as is the case with cold moulds in the initial casting. The problem is that the splinters must be removed at a separate machining stage later on, because if left in place, they may cause a short circuit at the electrolytic stage, where the anode 10 plates are hung in a vertical position at a very short distance from each other.

#### **OBJECT OF THE INVENTION**

The object of the invention is to eliminate the disadvantages 15 mentioned above.

In particular, the object of the invention is to disclose a method and equipment for casting anodes, which enable an increase in the cooling power and the capacity 20 of the anode foundry without increasing the number of moulds.

A further object of the invention is to disclose a method and equipment for casting anodes, which enable 25 cooling the anode without cooling the mould.

A further object of the invention is to disclose a method and equipment for anode casting, due to which the anode lugs are not essentially cooled, whereby no 30 splinters are formed and the anode does not crack.

#### **SUMMARY OF THE INVENTION**

The method according to the invention is characterized in that, which is disclosed in Claim 1. The anode 35 casting equipment according to the invention is further characterized in that, which is disclosed in Claim 10.

The method according to the invention comprises: a) casting a predefined amount of liquid metal into an open mould; b) cooling the anode cast in the mould at 5 cooling stages, where water is sprayed on the top surface of the anode; c) removing the solidified anode from the mould; and d) repeating the stages a)-c).

According to the invention, the cooling stages b) include one or more power cooling stages, wherein water 10 is sprayed on the top surface of the anode at high pressure, using at least one water spray, which is directed obliquely at the top surface of the anode so that the water spray passes by the lifting lugs of the 15 anode and the edge zone of the mould surrounding the lifting lugs without essentially touching them. The volume flow and the pressure of the water spray are selected so that the water spray penetrates the layer of steam that is possibly on the surface, gets into 20 contact with the anode surface and bounces from the anode surface over the edge zones of the mould from the opposite side of the mould edge zones, essentially without rinsing and cooling.

25 The anode casting equipment according to the invention includes a feeding device for feeding liquid metal and a number of open moulds for receiving the liquid metal from the feeding device. Each mould includes a recess 30 for forming a horizontal plate-like anode. The recess is surrounded by an essentially horizontal edge zone of the mould. One end of the recess comprises lug areas for forming the lifting lugs of the anode. Furthermore, the equipment includes quench condensation 35 equipment for cooling the anode cast in the mould with water sprays.

According to the invention, the quench condensation equipment includes at least one power cooling device, which is arranged to spray water on the top surface of the anode at high pressure with at least one water spray, which is directed obliquely at the top surface of the anode, so that the water spray passes by the edge zone of the mould and the lifting lugs of the anode without essentially touching them. The volume flow and the pressure of the water spray are selected so that the water spray penetrates the layer of steam that is possibly on the anode surface, gets into contact with the anode surface and bounces from the anode surface over the edge zone of the mould, from the opposite side of the mould edge zone with respect to the direction of the spray, essentially without rinsing and cooling.

An advantage of the invention is that no cooling is directed at the lifting lugs of the anode, which improves the quality of the anode and makes it possible to spray considerable amounts of water on the anode. In connection with cooling the anode, no excess cooling is directed at the edge zones of the mould, whereby the quality of the anode remains high. The invention provides a possibility to considerably increase the cooling capacity of the existing anode casting equipment, providing a chance to increase the casting capacity without increasing the number of moulds and the size of the casting table. A further advantage of the invention is that large amounts of water can be directed at the anode surface to provide economically significant cooling results (adequate to increase the capacity). A strong oblique water spray from the upstream cooling penetrates the steam layer formed by water on the anode surface, displacing it.

In one application of the method, the water spray of the power cooling stage is directed at an angle of 5-80° with respect to the anode top surface.

- 5 In one application of the method, the water of the power cooling stage that bounces from the anode is collected and directed downwards past the anode, without essentially touching the mould.
- 10 In one application of the method, the water spray of the power cooling stage that is sprayed on the anode is formed into a so-called flat water spray.

In one application of the method, water is sprayed at the power cooling stage at a volume flow that is in the order of 100-3000 l/min/m<sup>2</sup> and at a pressure of 2-7 bar.

In one application of the method, water is sprayed on the anode surface at the power cooling stage for 5-40 sec.

In one application of the method, the pattern of impact of the water spray on the anode surface at the power cooling stage is essentially elongated, such as rectangular, linear, elliptical or the like.

In one application of the method, water is sprayed at the power cooling stage with several water sprays, the impact patterns of which on the anode surface are essentially adjacent, covering the entire area of the anode top surface.

In one application of the method, after the power cooling stage has ended, the residual water is prevented from running on the anode and the mould.

5 In one application of the anode casting equipment, the anode casting equipment includes at least one spraying nozzle, which is directed to spray water at an angle of 5-80° with respect to the top surface of the anode.

10 In one application of the anode casting equipment, the power cooling device includes a guide, which is adapted, in the vicinity of and above the end of the mould, to collect and guide the splashing power cooling water downwards past the mould, essentially without touching the mould.

15 In one application of the anode casting equipment, the guide is mainly shaped as a downwards-opening chute.

In one application of the anode casting equipment, the spraying nozzle is adapted to form a so-called flat water spray.

20 In one application of the anode casting equipment, the spraying nozzle is arranged to form a water spray, the impact pattern of which on the anode surface is essentially elongated, such as linear, rectangular or elliptical.

25 In one application of the anode casting equipment, the power cooling device is arranged to spray water on the anode surface at a volume flow that is in the order of 100-3000 l/min/m<sup>2</sup>, and at a pressure of 2-7 bar.

In one application of the anode casting equipment, the power cooling device is arranged to spray water for 5-40 sec at a time during the power cooling stage.

In one application of the anode casting equipment, the power cooling device includes a number of spraying nozzles for directing several water sprays at the anode, so that the impact patterns of the water sprays 5 on the anode surface are essentially adjacent, covering the entire area of the anode top surface.

In one application of the anode casting equipment, the power cooling device includes a bypass manifold for 10 distributing the power cooling water to several spraying nozzles. In the bypass manifold, the spraying nozzles are arranged in the longitudinal direction at a distance from each other.

15 In one application of the anode casting equipment, the bypass manifold extends at least partly on top of the anode that is to be cooled. Each spraying nozzle is connected to the bypass manifold by a bended tube, which opens in the upper part of the bypass manifold 20 to prevent the residual water from running.

In one application of the anode casting equipment, the bypass manifold is vertical and arranged, with respect 25 to the mould, so that the spraying nozzles extend to a vertical plane that is at a distance from the mould, whereby after the power cooling spraying, the residual water that possibly runs from the spraying nozzles runs past the mould without touching and cooling it.

### 30 **DRAWINGS**

In the following, the invention is described in detail by means of application examples and with reference to the appended drawing, wherein

Fig. 1 shows a schematic top view of an application of the anode casting equipment according to the invention;

5 Fig. 2 shows the section II-II of Fig. 1;

Fig. 3 is an axonometric drawing of an anode manufactured by the anode casting equipment of Fig. 1;

10 Fig. 4 shows one mould of the anode casting equipment of Fig. 1;

Fig. 5 is an axonometric drawing of one power cooling device of the anode casting equipment of Fig. 1;

15 Fig. 6 shows a side view of the power cooling device of Fig. 5, and the cross sections of the mould and the anode.

20 Fig. 7 shows a side view of another application of the power cooling device; and

Fig. 8 shows a top view of the device of Fig. 7.

25 **DETAILED DESCRIPTION OF THE INVENTION**

Figs. 1 and 2 show the anode casting equipment, which includes a number of open moulds 2, in which liquid metal, such as copper, is cast from the casting chute of the feeding device 1 for forming anodes 4. The 30 moulds 2 are arranged in a horizontal circle around the vertical axis on top of the rotatable casting table 15. The casting table 15 is rotated periodically, so that each move is followed by a stop of a specific duration.

Fig. 4 shows that each mould 2 includes a recess 3 for forming the horizontal plate-like anode 4. The recess 3 is surrounded by an essentially horizontal edge zone 5 of the mould. One end of the recess 3 comprises lug areas 6 for forming the lifting lugs 7 of the anode. Fig. 3 shows the anode 4 of Fig. 4, which is to be formed, comprising lifting lugs 7. Typically, the size of the anode 4 is about 1 m x 1 m, its thickness is about 5 cm and its weight about 300-400 kg.

10

When liquid metal, such as copper, is cast in the mould 2, the temperature of the metal is about 1150 °C. After the anode 4 has been cast in the mould, the casting table 15 moves it to the cooling stage, which 15 is carried out by cooling equipment 8. The anode is cooled by the cooling equipment 8 by spraying the anode surface with water sprays in several sequential stopping positions. The cooling equipment 7 includes a hood 16, by which the steam generated during cooling is removed. In the cooling equipment 7, the water sprays are 20 sprayed by upstream nozzles, which are placed directly on top of the anodes, forming a full conical spray. In this application, the cooling equipment 8 comprises, in the rotation direction of the casting table, three 25 power cooling devices 9, which carry out the power cooling stages. After the power cooling devices 9, one end of the anode is raised off the mould by push pins 17 provided in the bottom of the mould 2 (see Figs. 2 and 4). An ejector 18 grips the anode and takes it to 30 final cooling. When removed from the mould, the temperature of the anode is about 700-950 °C.

The cooling equipment 8 preferably comprises about 3-4 power cooling devices 9. The power cooling stages can 35 be initiated immediately, when the anode surface is cool enough to endure cooling without sagging. The

power cooling is preferably distributed to as many power cooling devices 9 as possible, as then the cooling is easier and more exact to control than when implemented in one position. The spraying time at a single power cooling device 9 may be, for example, about 10 seconds, and it takes time at the first power cooling stage for the surface temperature of the anode to decrease to a temperature, where the anode no longer emits a yellow glow. It is preferable to effectively decrease the temperature of the anode right at the beginning of the cooling, as it is much more difficult to take heat energy out of an anode that has a temperature of, e.g., about 1000 °C than from an anode that has a temperature of, e.g., about 800 °C.

15

After the anode has been removed from the mould, the mould advances to a painting stage 19, wherein a release agent, e.g., barium sulphate mixed with water is painted on the surface of the mould recess and dried for a while, when the mould moves ahead. After this, the mould 2 is ready for casting another anode.

Fig. 5 shows the power cooling device 9, which is arranged to spray water on the top surface of the anode 4 at high pressure and with twenty water sprays 10, at the most, each of them being directed obliquely at the top surface of the anode 4, so that the water spray passes by the edge zone 5 of the mould and the lifting lugs 7 of the anode without touching them, whereby the water spray does not essentially cool the mould. The volume flow and the pressure of the water spray 10 are selected so that the water spray penetrates the layer of steam, which is formed by water that is left on the anode surface from the previous spraying stages, and gets into contact with the surface of the anode 4. The impact patterns of the water sprays 10 on the anode

surface are essentially adjacent, covering the entire area of the top surface of the anode 4.

5 The water that is fed at high pressure bounces from the surface of the anode 4 over the edge zone 5 of the mould, from the opposite side of the edge zone of the mould with respect to the direction of the spray, without essentially rinsing and cooling. The anodes lie in the moulds so that the lifting lugs 7 are on 10 the side of the periphery of the casting table 15 and the water sprays 10 are directed towards the centre of the casting table.

15 A guide 12 is adapted in the vicinity of and above the end of the mould 4 to collect and guide the upwards-splashing power cooling water downwards past the mould, so that the water does not essentially touch and cool the mould. The guide 12 is shaped as a mainly 20 downwards-opening chute, which is closed by end walls at both ends.

25 The spraying nozzles 11 are directed so as to spray water at an angle of 5-80° with respect to the anode top surface. The spraying nozzle 11 forms a water spray 10, the impact pattern of which on the anode surface is essentially elongated, such as linear, rectangular, or has a flat elliptical shape. At its simplest, the spraying nozzle 11 is the head of a tube that is pressed flat. Shaping nozzles can also be used 30 to provide fan or flat water sprays of a preferable shape.

35 The power cooling device 9 sprays water on the surface of the anode 4 at a volume flow rate of 100-3000 l/min/m<sup>2</sup> and a pressure of 2-7 bar. The maximum spraying time, during which this amount of water should be

sprayed on the anode, depends on the time of the stopping cycle of the casting table; accordingly, the power cooling device 9 can be arranged so as to spray water on the anode for 5-40 sec at a time.

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Referring to Figs. 5-8, the power cooling device 9 includes a bypass manifold 13, which distributes the power cooling water at the same pressure to several spraying nozzles 11. The bypass manifold 13 comprises spraying nozzles 11 at a distance from each other.

10 In Figs 5 and 6, the bypass manifold 13 is bifurcated, each branch extending in a parallel relationship on top of the anode 4 that is to be cooled. The spraying nozzles 11 are connected to the bypass manifold 13 by bended tubes 14, which open in the upper part of the bypass manifold 13. Thus, no water is left running from the nozzles on the anode and the mould after spraying. Furthermore, a quick discharge conduit can 15 be arranged in the connecting part of the bypass manifold 13, through which conduit the residual water is removed.

20 In Figs. 7 and 8, the bypass manifold 13 is vertical and arranged, with respect to the mould 2, so that the spraying nozzles 11 extend not higher than to a vertical plane that is at a distance S from the mould 2. After ending the power cooling spraying from the nozzles 11, any running residual water runs past the 25 mould without touching and cooling it.

30 The invention is not limited to the application examples described above only, but many modifications are possible within the inventive idea defined by the 35 claims.

**CLAIMS:**

1. A method of casting anodes, comprising
  - a) casting a predefined amount of liquid metal in an open mould;
  - b) cooling the anode that was cast in the mould at cooling stages, wherein water is sprayed on the top surface of the anode;
  - c) removing the solidified anode from the mould;
  - d) repeating the stages a)-c);

**characterized** in that the cooling stages b) include one or more power cooling stages, wherein water is sprayed on the top surface of the anode at high pressure with at least one water spray, which is directed obliquely at the anode top surface, so that the water spray passes by the lifting lugs of the anode and the edge zone of the mould surrounding the lifting lugs without essentially touching them; and that the volume flow and the pressure of the water spray are selected so that the water spray penetrates the layer of steam that is possibly on the surface, gets into contact with the anode surface and bounces from the anode surface over the edge zones of the mould from the opposite sides of the mould edge zones, essentially without rinsing and cooling.

- 2. A method according to Claim 1, **characterized** in that the water spray of the power cooling stage is directed at an angle of 5-80° with respect to the anode top surface.
- 3. A method according to Claim 1 or 2, **characterized** in that the water of the power cooling stage that bounces from the anode is collected and conveyed down-

wards past the mould without essentially touching the mould.

4. A method according to any of Claims 1-3, **characterized** in that the water spray of the power cooling stage that is sprayed on the anode is shaped as a flat water spray.

5. A method according to any of Claims 1-4, **characterized** in that, at the power cooling stage, water is sprayed at a volume flow that is in the order of 100-3000 l/min/m<sup>2</sup> and at a pressure of 2-7 bar.

6. A method according to any of Claims 1-5, **characterized** in that, at the power cooling stage, water is sprayed on the surface of the anode for 5-40 sec.

7. A method according to any of Claims 1-6, **characterized** in that the impact pattern of the water spray on the anode surface at the power cooling stage is essentially elongate, such as rectangular, linear or elliptical.

8. A method according to any of Claims 1-7, **characterized** in that water is sprayed at the power cooling stage with several water sprays, the impact patterns of which on the anode surface are essentially adjacent, covering the entire area of the anode top surface.

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9. A method according to any of Claims 1-8, **characterized** in that after ending the power cooling stage, the residual water is prevented from running on the anode and the mould.

35

10. Anode casting equipment, comprising

- a feeding device (1) for feeding liquid metal;

5 - a number of open moulds (2) for receiving liquid metal from the feeding device (1), each mould including a recess (3) for forming a horizontal plate-like anode (4), the recess (3) being surrounded by an essentially horizontal edge zone (5) of the mould, lug areas (6) being provided at one end of the recess (3) for forming the lifting lugs (7) of the anode; and

10 - quench condensation equipment (8) for cooling the anode that is cast in the mould with water sprays, **characterized** in that the quench condensation equipment (8) includes at least one power cooling device (9), which is arranged to spray water on the top 15 surface of the anode (4) at high pressure with at least one water spray (10), which is directed obliquely at the top surface of the anode (4), so that the water spray passes by the edge zone (5) of the mould and the lifting lugs (7) of the anode without 20 essentially touching them; and that the volume flow and the pressure of the water spray (10) are selected so that the water spray penetrates the layer of steam that is possibly on the anode surface, gets into contact with the anode surface and bounces from the anode 25 surface over the edge zone (5) of the mould, from the opposite side of the mould edge zone with respect to the direction of the spray, without essentially rinsing and cooling.

30 11. Anode casting equipment according to Claim 10, **characterized** in that the power cooling device (9) includes at least one spraying nozzle (11), which is directed to spray water at an angle of 5-80° with respect to the top surface of the anode.

12. Anode casting equipment according to Claim 10 or 11, **characterized** in that the power cooling device (9) includes a guide (12), which is adapted, in the vicinity of and above the end of the mould (4), to collect 5 and guide the upwards-splashing power cooling water downwards past the mould without essentially touching the mould.

13. Anode casting equipment according to Claim 12, 10 **characterized** in that the guide (12) is shaped as a mainly downwards-opening chute.

14. Anode casting equipment according to any of Claims 10-14, **characterized** in that the spraying nozzle (11) 15 is arranged to form a water spray (10), the impact pattern of which on the anode surface is essentially elongated, such as linear, rectangular, or has a flat elliptical shape.

20 15. Anode casting equipment according to Claim 14, **characterized** in that the spraying nozzle (11) is adapted to form a fan or flat water spray.

16. Anode casting equipment according to any of Claims 25 10-15, **characterized** in that the power cooling device (9) is arranged to spray water on the anode surface at a volume flow of 100-3000 l/min/m<sup>2</sup> and a pressure of 2-7 bar.

30 17. Anode casting equipment according to any of Claims 10-16, characterized in that the power cooling device (9) is arranged to spray water on the anode for 5-40 sec at a time.

35 18. Anode casting equipment according to any of Claims 10-17, **characterized** in that the power cooling device

includes a number of spraying nozzles (11) for directing several water sprays (10) at the anode (4), so that the impact patterns of the water sprays on the anode surface are essentially adjacent, covering the 5 entire area of the anode top surface.

19. Anode casting equipment according to any of Claims 10-18, **characterized** in that the power cooling device (9) includes a bypass manifold (13) for distributing 10 the power cooling water to several spraying nozzles (11); and that the spraying nozzles (11) are arranged at a distance from each other in the longitudinal direction of the bypass manifold (13).

15 20. Anode casting equipment according to Claim 19, **characterized** in that the bypass manifold (13) extends at least partly on top of the anode (4) to be cooled; and that each spraying nozzle (11) is connected to the bypass manifold (13) by a bended tube (14), which 20 opens in the upper part of the bypass manifold.

21. Anode casting equipment according to Claim 20, **characterized** in that the bypass manifold (13) is vertical and arranged with respect to the mould (2) so 25 that the spraying nozzles (11) extend not higher than a vertical plane that is at a distance (S) from the mould (2), whereby after the power cooling spraying, any residual water possibly running from the spraying nozzles (11) runs past the mould without touching and 30 cooling it.

22. Anode casting equipment according to any of Claims 10-21, **characterized** in that the lug areas (6) of the moulds (2) are on the side of the periphery of a circular path; and that the water sprays (10) are directed 35 towards the centre of the circular path.

23. Anode casting equipment according to Claim 22,  
**characterized** in that the anode casting equipment in-  
cludes a rotatable casting table (15), on which the  
5 moulds (2) are arranged in a circle; that the lug ar-  
eas (6) of the moulds (2) are on the side of the pe-  
riphery of the casting table; and that the water spray  
(10) is directed towards the centre of the casting ta-  
ble.

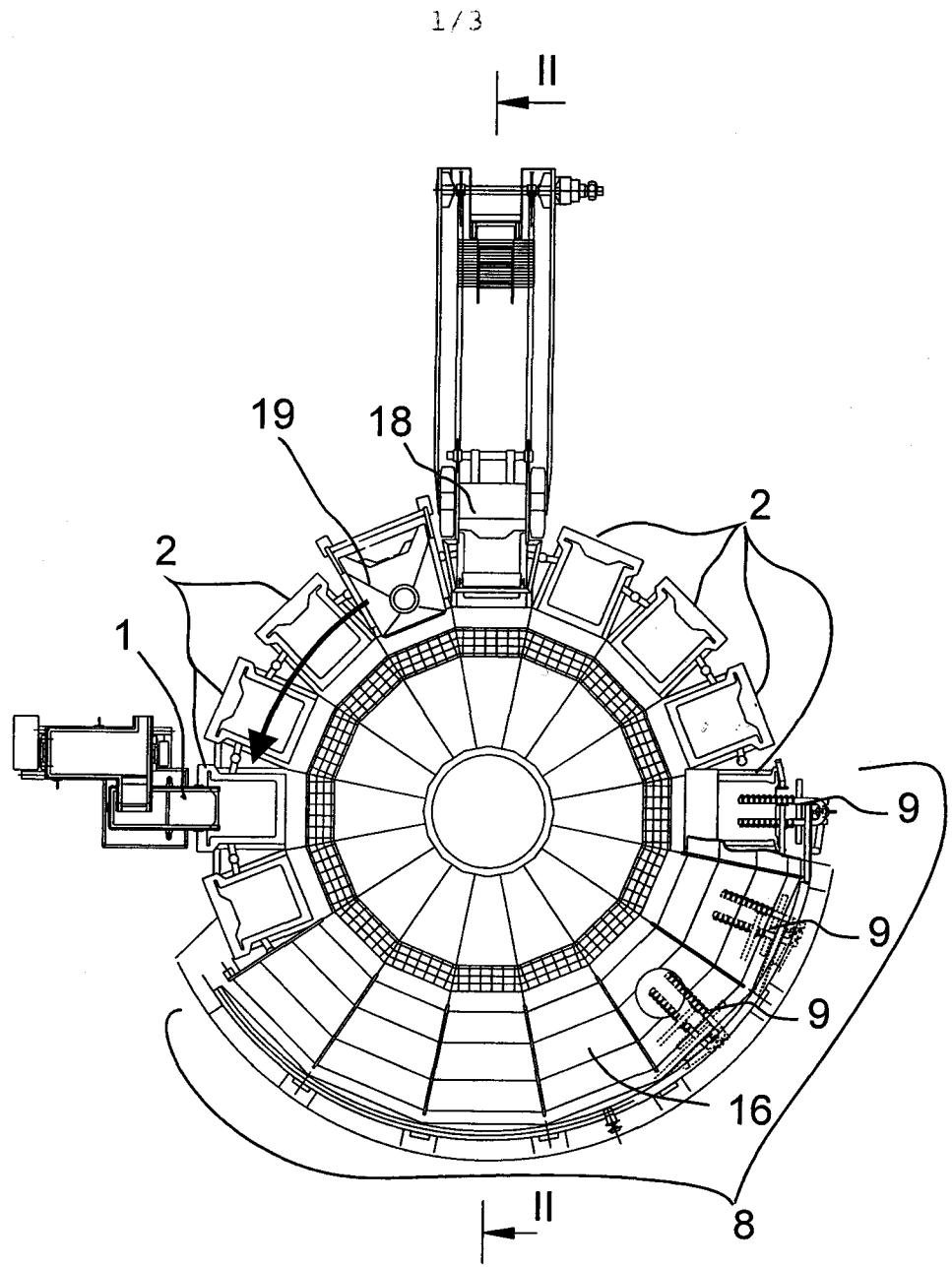


Fig. 1

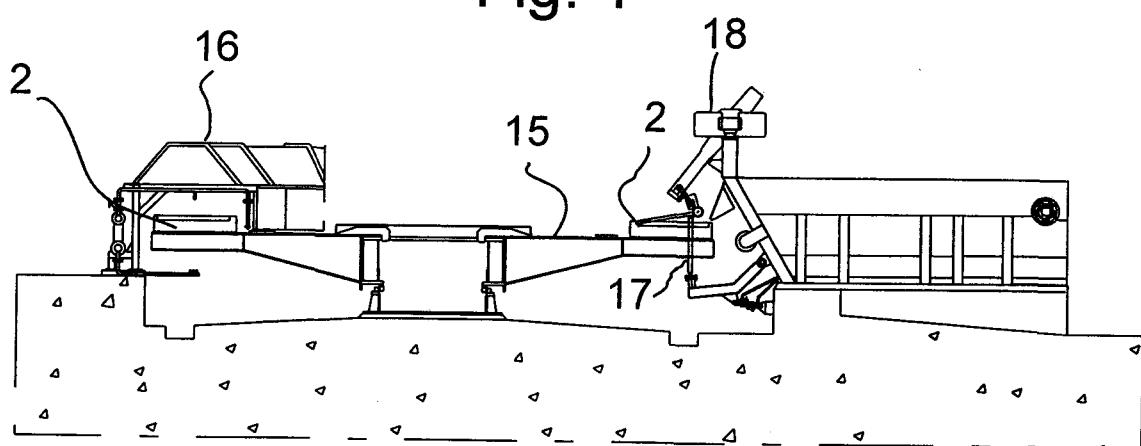


Fig. 2

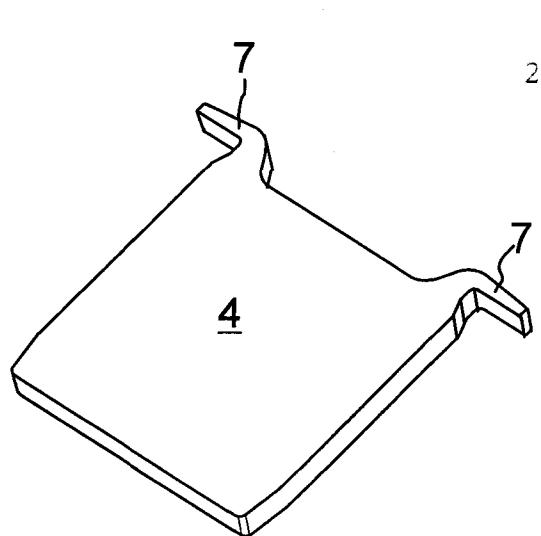


Fig. 3

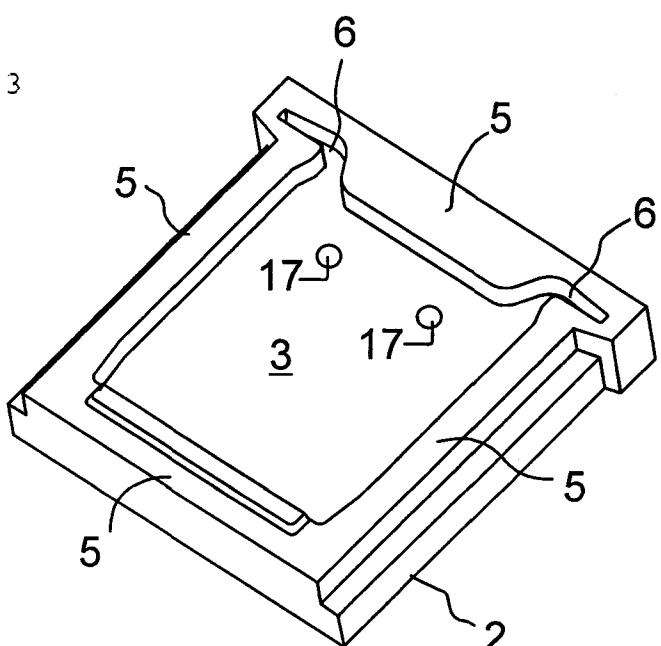


Fig. 4

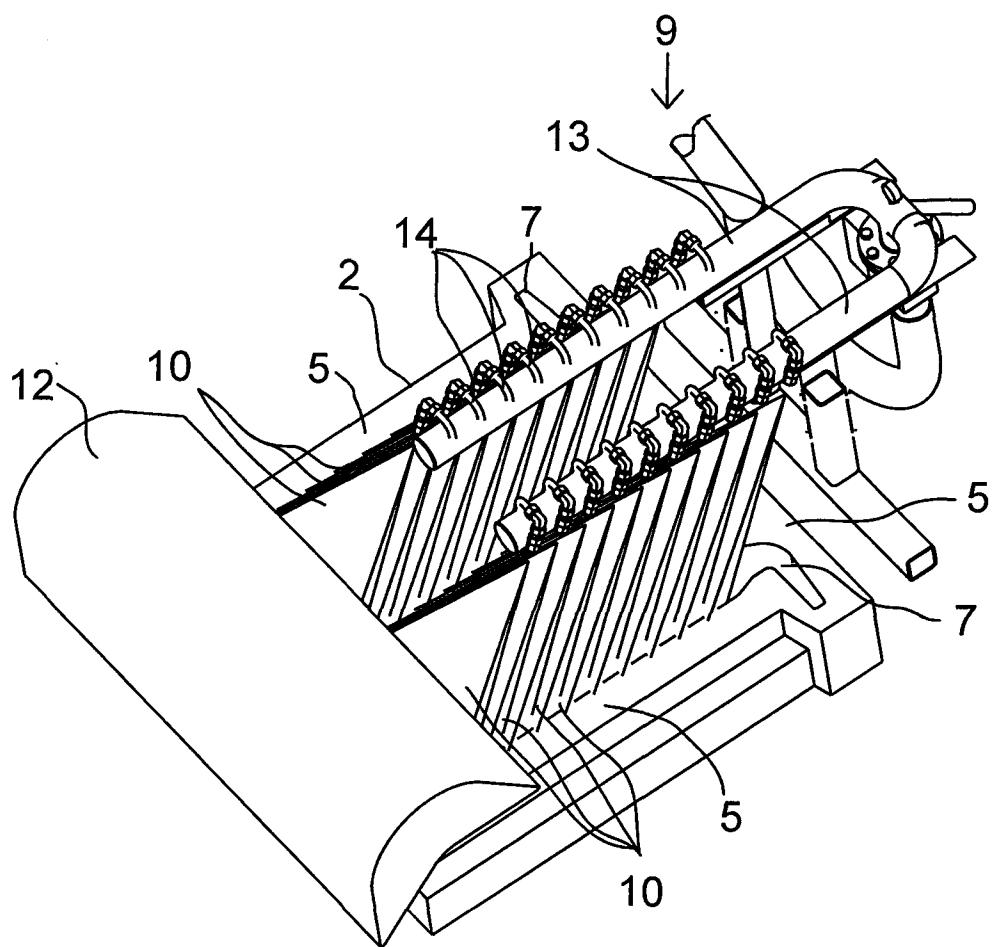


Fig. 5

Fig. 6

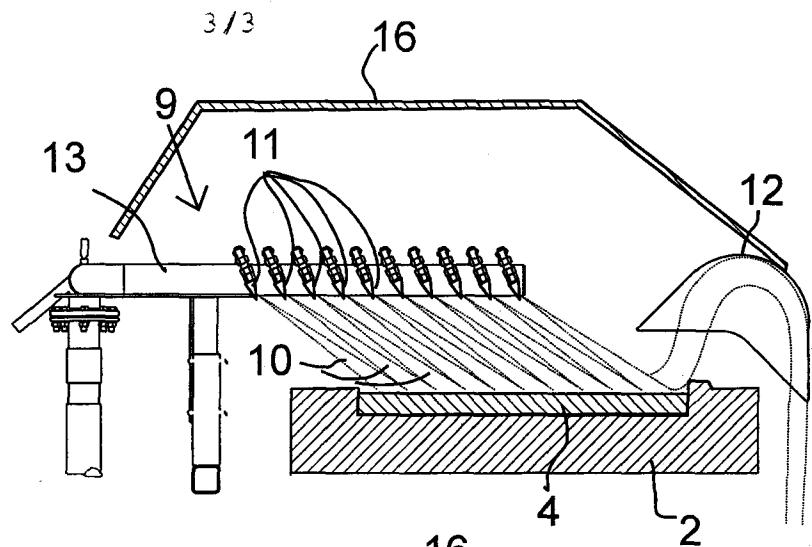


Fig. 7

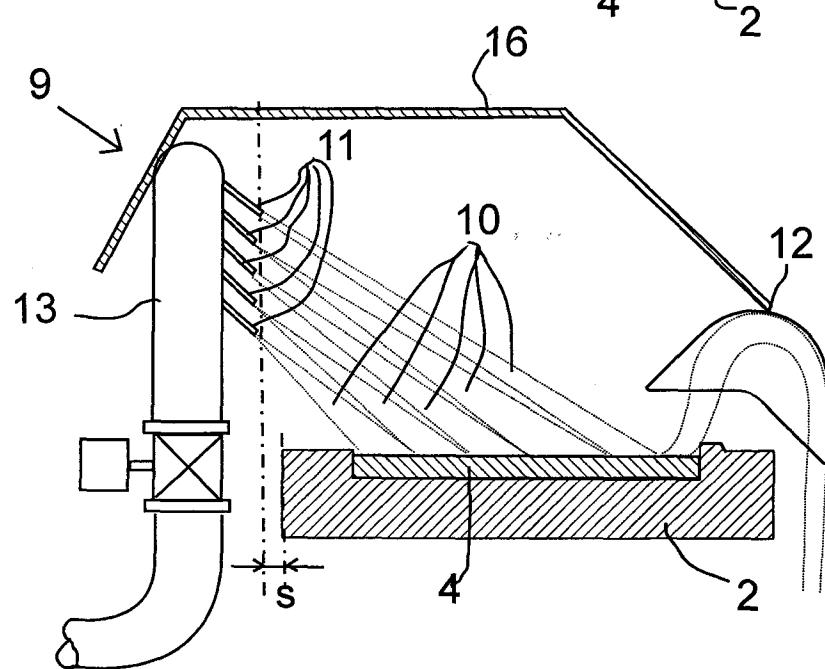
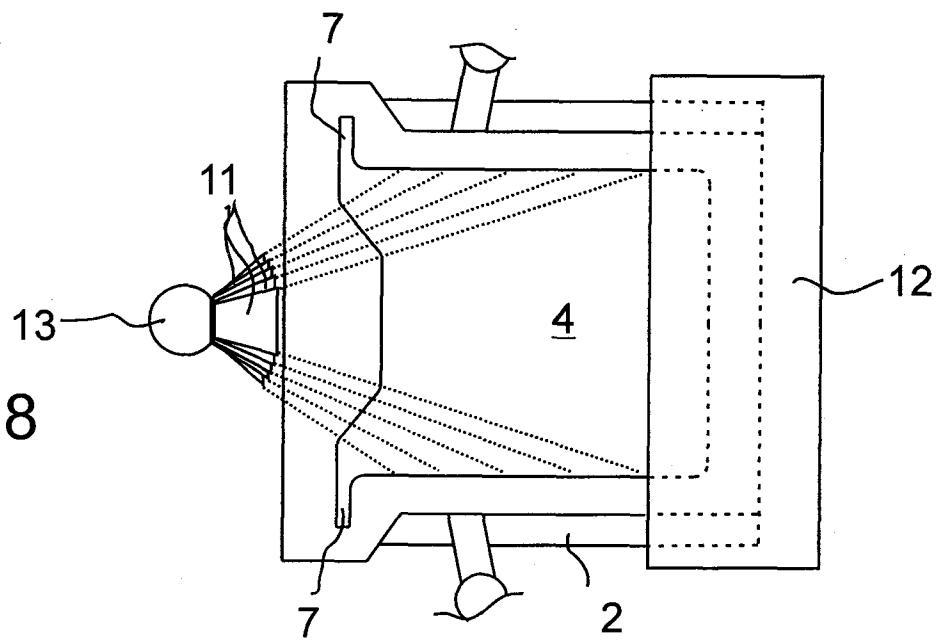


Fig. 8



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2009/050164

## 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: B22D, B22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
FI, SE, NO, DKElectronic 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.
A	WO 2007128861 A1 (OUTOTEC OYJ et al.) 15 November 2007 (15.11.2007), page 1, lines 3-4 and lines 21-23, page 4, lines 10-12 and lines 17-19 and lines 21-22, page 5, lines 4-31, Figs. 1-3	1-23
A	JP 4253562 A (SUMITOMO METAL MINING CO) 09 September 1992 (09.09.1992), abstract in Patent Abstracts of Japan	
A	JP 7032090 A (SUMITOMO METAL MINING CO) 03 February 1995 (03.02.1995), abstract in Patent Abstracts of Japan	
A	JP 2003205354 A (SUMITOMO METAL MINING CO) 22 July 2003 (22.07.2003), abstract in Patent Abstracts of Japan	
A	JP 62104665 A (AKITA SEIREN KK et al.) 15 May 1987 (15.05.1987), abstract in Patent Abstracts of Japan	

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search  
16 June 2009 (16.06.2009)Date of mailing of the international search report  
24 June 2009 (24.06.2009)Name and mailing address of the ISA/FI  
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INTERNATIONAL SEARCH REPORT

International application No.  
PCT/FI2009/050164

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

**B22D 5/02** (2006.01)

**B22D 25/04** (2006.01)

**B22D 30/00** (2006.01)

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.  
PCT/FI2009/050164

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JP 4253562 A	09/09/1992	None	
JP 7032090 A	03/02/1995	None	
JP 2003205354 A	22/07/2003	None	
JP 62104665 A	15/05/1987	None	