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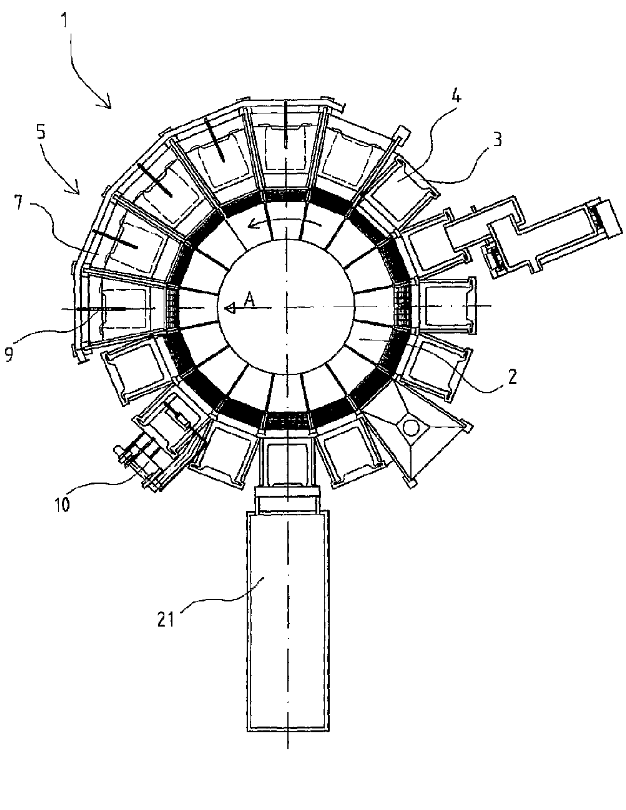
(54) Title: METHOD AND EQUIPMENT FOR COOLING ANODES



(57) Abstract: The invention relates to a method and equipment for cooling anodes (4) in connection with anode casting (1), so that in the cooling unit (5), in between cooling steps, water is removed from the anode surface at least once before removing the anode (4) from the cooling unit (5).

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METHOD AND EQUIPMENT FOR COOLING ANODES

The present invention relates to a method and equipment for cooling anodes in connection with anode casting.

The blister copper created in the conversion step of the pyrometallurgic copper process is further refined in an anode furnace in order to lower the sulfur content of blister copper. After the anode furnace treatment, copper is cast into copper anodes by pouring molten copper into casting molds. The cast copper anodes are purified in copper electrolysis into copper cathodes with a copper content of over 99.99%. At present, the most widely used anode casting equipment comprises a rotary casting table, where several, often tens of casting molds are arranged in a circle. Generally the casting table is provided with a cooling unit, where the pieces are cooled in their casting molds for example by water.

In an anode casting plant, an anode cast in a mold cannot be cooled before the surface is sufficiently solid. A cast anode with a temperature of roughly 1150° C must be cooled in order to be able to disengage it from the mold, generally at a temperature of roughly 700 – 900° C. It is a known method to cool anodes while the anode casting table rotates, so that at the spot where the casting wheel stops, there are arranged nozzles above the anodes for spraying cooling water onto the anode surface. In addition, in connection with the nozzles there is arranged a hood for removing vapor created in the cooling process. Anodes are known to be cooled by directing a water jet onto the anode surface, when the anode surface is sufficiently solidified, and hence the water jet directed to the anode does not harm its surface. By means of spraying cooling water, the cooling capacity of the casting table can be adjusted during momentary changes in the casting capacity, so that a desired heat amount can be removed from the anodes prior to lifting them into the cooling tank. Water spraying is controlled according to the casting situation, and it can be for example interrupted, if cooling is not needed owing to an interruption in the casting process.

When anode cooling is desired to be boosted by increasing the quantity of cooling water, the resulting problem are the disturbances caused by excessive cooling water. If too much water is sprayed at the first water cooling spot, there is created an insulating water foam layer on the anode surface owing to the effect of boiling water. In case water is added after that, the created water foam layer prevents the cooling water from proceeding onto the anode surface, and the sprayed water only participates in preserving the water foam layer. Thus the problem is that while the anode is in the mold, the water accumulated on the anode surface cannot be removed from the mold, but it remains to disturb the cooling process. After cooling, there should not be left any water on the anode surface, because it disturbs the preliminary disengagement of the anode, i.e. water is conveyed under the anode when lifting the anode from the mold. When the anode is lowered back in the mold, the water left underneath it creates for example a vapor cloud that disturbs visibility.

The object of the present invention is to eliminate drawbacks of the prior art and to realize a new method to make anode cooling more effective in connection with anode casting. A particular object of the invention is to make cooling more effective by removing cooling water from anode surfaces in between the cooling steps.

According to the present invention, there is provided a method for cooling anodes in connection with anode casting, in which molten metal is cast in the mold of an anode casting wheel, said anode casting wheel conveying the anode in the mold into a cooling unit, where the anode is cooled by feeding water onto the anode surface in at least two cooling steps, and wherein the method includes removing cooling water from the surface of the anode at least once between the cooling steps by directing a medium agent jet onto the surface of the anode at an angle with respect to the anode surface while in the cooling unit and after the cooling steps, the anode is disengaged from the mold in a disengaging unit.

According to the present invention, there is also provided equipment includes a dewatering system, constituting at least two adjacently positioned nozzles for feeding medium agent, such as water or air, onto the anode surface

One of the benefits is that the cooling of anodes may be more effective. The anodes may be cooled in connection with casting, so that molten metal is cast in a mold of an anode casting wheel, said anode casting wheel moving the anode cast in a mold into an anode cooling unit, where the anode is cooled by feeding water onto the anode surface in at least two steps, after which cooling the anode is disengaged from the mold in a disengaging unit, so that cooling water is removed from the anode surface in the cooling unit in between cooling steps, at least once before removing the anode from the cooling unit. The quantity of cooling water in each cooling step can be added, so that the anode temperature is maintained within a safe range without disturbing the casting process by even larger additions of cooling water. The cooling water may be removed from the anode surface by directing onto the surface of a moving anode a jet of a medium agent, such as a water jet or an air jet, by at least two nozzles, at a suitable angle, preferably at an angle of 20 – 50 degrees with respect to the anode surface. By pressurizing the medium agent onto the anode surface, it peels the excessive cooling water located on the anode surface while the anode moves in the anode casting wheel. The medium agent jet may be fed onto the anode surface at a suitable height, preferably at the height of 200 – 300 millimeters from the anode surface. In the cooling unit, the anode surface may be cooled by feeding cooling water onto the anode surface in five cooling steps, so that water is removed from the anode surface at least twice. The cooling water may be removed from the anode surface in a direction opposite to the rotary direction of the anodes in the casting wheel. Thus the removed cooling water does not disturb anode casting. The water may be fed onto the anode surface at a rate of preferably 10 – 120 liters per minute, at a pressure of

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3 – 5 bar for removing excessive cooling water. The equipment may include a dewatering system constituting at least two adjacently positioned nozzles for feeding a medium agent, such as water or air, onto the anode surface. Advantageously the position of the dewatering system may be adjustable. If the arrangement is used for the water cooling of anodes, it does not increase the cost of the casting equipment, because water can be recycled, and the same water can be used both for cooling and for anode peeling. The equipment may include two dewatering systems arranged in succession, both of which are provided with nozzles in at least one row, so that the distance between successively effective jet rows is preferably 50 – 200 millimeters.

An emobidment of the invention is described in more detail with reference to the appended drawings, where

Figure 1 illustrates an anode casting equipment,
Figure 2 illustrates a cross-section of Figure 1, seen in the direction A, and
Figure 3 illustrates anode cooling according to the invention.

Figures 1, 2 and 3 illustrate equipment according to an embodiment of the invention for anode cooling. The anode casting equipment 1 includes an anode casting wheel 2, in the molds 3 of which anodes 4 are cast. When molten metal, such as copper, is cast in a mold 3, its temperature is roughly 1150° C. After the anode is cast, it is transferred along with the rotation of the anode casting wheel 2 to the next anode casting step, i.e. to the cooling step. In the cooling unit 5, the surface 6 of the anode 4 is cooled, in order to lower its temperature prior to disengaging the anode from the mold. The cooling unit 5 is provided with a hood 7, through which the vapors created during the cooling process are removed. In the cooling unit 5, onto the surface 6 of the anode 4, there is fed cooling water 8 by upper water jets 9 positioned above the anodes. As the anode casting wheel 2 rotates, the anode is conveyed to be cooled in the next cooling step, if necessary. After the cooling unit, the anode proceeds to the disengagement step 10, where the anode is disengaged from the mold 3 while the anode temperature is 700 – 900 degrees. Then the anode 4 is transferred further to the cooling and purification step 21, and when necessary, to further treatment.

Excessive cooling water may be removed from the anode surface 6 at least once in between the cooling steps 11 – 15 taking place in the cooling unit 5. One cooling step is understood to be a step where cooling water is sprayed onto the anode surface for a necessary time by the top water jets 9. According to the example, after casting the anode is conveyed to the cooling step 11, where cooling water is sprayed onto the anode surface 6 for cooling the anode. According to the example, after the cooling step 11, excessive cooling water is removed from the anode surface prior to the next cooling step 12. The means for removing the cooling water, i.e. the dewatering system 16, is at least partly positioned in the space left in between the molds 3 arranged in the anode casting wheel. Cooling water 8 is removed from the anode surface 6 by pressurizing, for instance by a pump, water onto the anode surface, so that the water dislocates the cooling water from the anode surface. In connection with the equipment, there is arranged a water connection 22, from which the water to both the top water jet and to the dewatering system 16 can be taken. According to the example, the water is pressurized in a pipe 17 or the like extending along the width of the anode 4, through which the water is further fed to the nozzles 18. The nozzles, for instance fan nozzles or flat nozzles, feed the water, preferably at the rate of at least 10 liters per minute (= l/min), in jets at a suitable pressure, such as 3 – 5 bar, onto the surface of a moving anode, as the molds proceed for one sequence, for example for 1 – 2 molds, in the casting wheel. At the same time, owing to the effect of the aqueous curtain 19 created by the pressurized water, the excessive water located on the anode surface is peeled onto the opposite side of the anode surface 6, with respect to the proceeding direction 20 of the anode. Thus the anode 4 is nearly dry before the next cooling step 12, and cooling water can be added and thus the cooling process can be boosted. According to an example, an anode is cooled in five different cooling steps 11 – 15, in which case cooling water is removed from the anode surface

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in two steps, after the first water cooling 11 and immediately before removing the anode from the cooling unit 5 after the last cooling step 15. Obviously cooling water could be removed from the anode surface within the scope of the embodiments of the invention also after each water cooling step 11 – 15. According to an example, water is fed onto the anode surface at a distance C, which according to the example is located at 200 – 300 millimeters from the anode surface, so that the peeling effect created by the infed aqueous curtain 19 is most advantageous. An advantageous solution for an effective removal of cooling water is to place the nozzles at an angle B of 20 – 50 degrees with respect to the surface 6 of the moving anode.

In the dewatering system 16, nozzles 18 can also be arranged for feeding water in several rows, in which case the number of the pipes 17 can also be two or more. When necessary, part of the nozzles 18 can be taken away from use, and they can be used only for part of the anodes. In Figure 3 it is shown how the pipe 17 and the nozzles 18 are arranged with respect to the mold 3. The angle D between the dewatering system 16 and the top water jet 9 can vary according to where the cooling water to be removed is directed by means of the peeling aqueous curtain 19.

For a man skilled in the art, it is apparent that the various embodiments of the invention are not restricted to the examples described above, but may vary within the scope of the appended claims.

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CLAIMS

1. A method for cooling anodes in connection with anode casting, in which molten metal is cast in the mold of an anode casting wheel, said anode casting wheel conveying the anode in the mold into a cooling unit, where the anode is cooled by feeding water onto the anode surface in at least two cooling steps, and wherein the method includes removing cooling water from the surface of the anode at least once between the cooling steps by directing a medium agent jet onto the surface of the anode at an angle of 20-50 degrees with respect to the anode surface at a pressure of 3-5 bar while in the cooling unit and after the cooling steps, the anode is disengaged from the mold in a disengaging unit.

2. The method according to claim 1, wherein that the medium agent jet is water.

3. The method according to any one of claims 1, wherein the medium agent jet is air.

4. The method according to any one of claims 1 to 3, wherein the medium agent jet is fed onto the anode surface at a suitable height, preferably at the height of 200 – 300 millimeters from the surface of the anode.

5. The method according to any one of claims 1 to 4, wherein the medium agent jet is fed through at least two nozzles.

6. The method according to claim 1, wherein the cooling unit, the surface of the anode is cooled by feeding water onto the surface of the anode in five cooling steps and method includes removing the cooling water from the surface of the anode at least twice.

7. The method according to claim 1, wherein the cooling water is removed from the surface of the anode in a direction opposite to the rotary direction of the anode in the anode casting wheel.

8. The method according to any one of claims 1 to 8, wherein the medium agent is water and is supplied at a rate of 10 – 120 liters per minute.

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9. The equipment for cooling anodes in connection with anode casting, in which case the anode casting wheel includes a mold in which the metal of the melt can be cast, and which anode can be further transferred to a cooling unit, where the anode can be cooled by spraying cooling water onto the anode surface in at least two cooling steps, wherein the equipment includes nozzles for removing cooling water from a surface of the anode, the nozzles being arranged for directing a medium agent jet onto the surface of the anode at an angle of 20-50 degrees with respect to the anode surface, at a pressure of 3-5 bar to remove cooling liquid from the surface of the anode while in the cooling unit, whereafter the anode can be disengaged from the mold.

10. The equipment according to claim 9, wherein the equipment includes a dewatering system, constituting at least two adjacently positioned nozzles for feeding medium agent, such as water or air, onto the anode surface.

11. The equipment according to claim 10, wherein the dewatering system includes means for conveying the medium agent into the nozzles.

12. The equipment according to claim 10 or 11, wherein the dewatering system is at least partly arranged in the space left between the molds provided in the anode casting wheel.

13. The equipment according to any one of claims 10 to 12, wherein the nozzles are arranged to direct a medium agent onto the surface of the anode at an angle of 20 – 50 degrees with respect to the anode surface.

14. The equipment according to claim 10 or 11, wherein the equipment includes an upper water jet for supplying cooling water onto a surface of the anode, and an angle between the dewatering system and the upper jet can be changed in the horizontal direction.

15. The equipment according to any one of claims 10 to 14, wherein the nozzles are arranged at a distance of 200 – 300 millimeters from the anode surface in the vertical direction.

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16. The equipment according to any one of claims 10 to 15, wherein the equipment includes two dewatering systems arranged in succession, both of which are provided with nozzles in at least one row, so that the distance between successively effective jet rows is 50 – 200 millimeters.

17. A method for cooling anodes substantially as hereinbefore described with reference to the accompanying Figures.

18. Equipment for cooling anodes substantially as hereinbefore described with reference to the accompanying Figures.

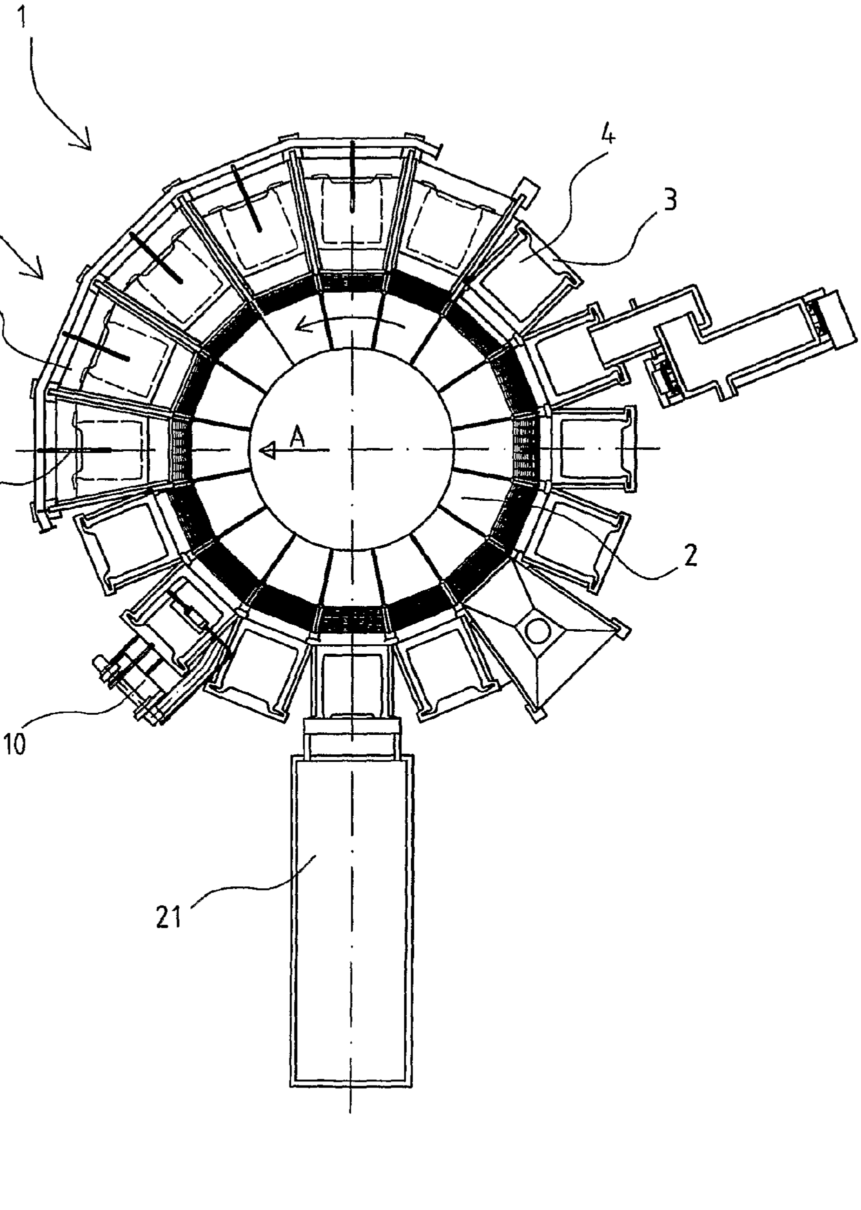

Fig. 1

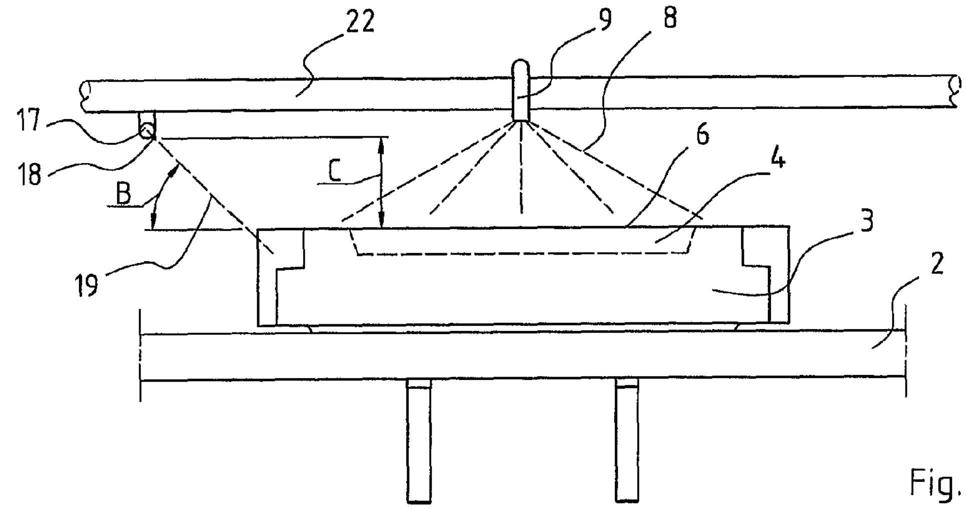

Fig. 2

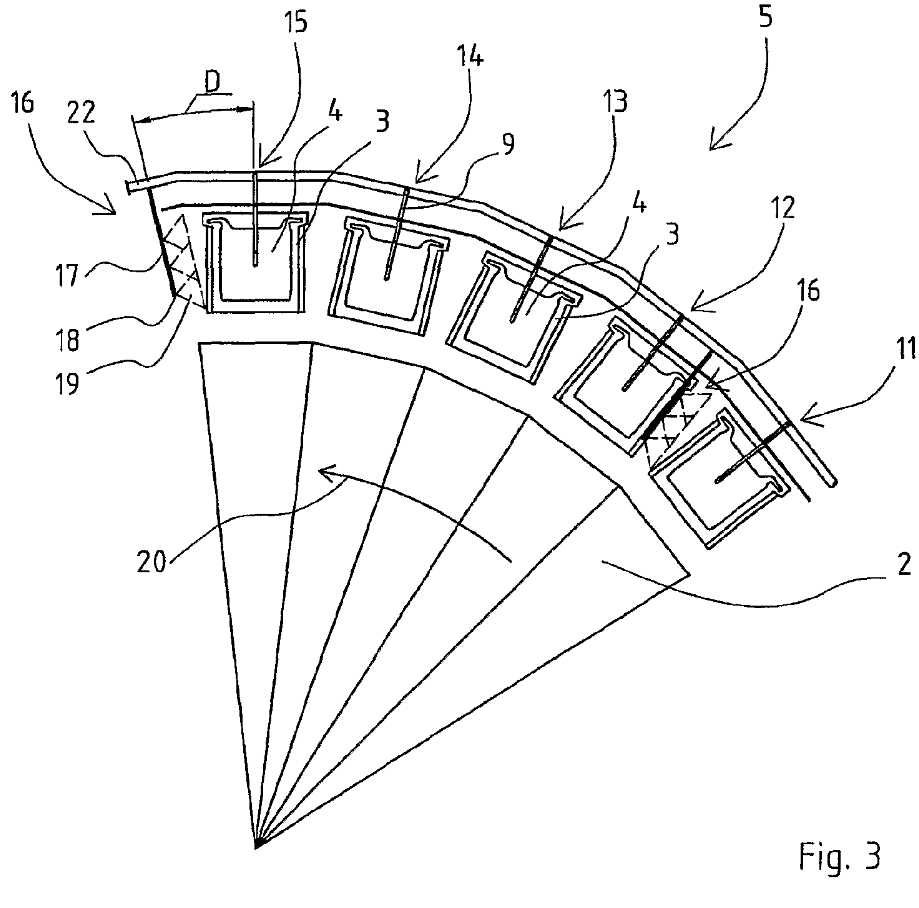

Fig. 3