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(54) **CATHODE DEVICE FOR AN ALUMINIUM ELECTROLYSIS CELL**

(57) The cathode assembly of a reduction cell for aluminium production contains a metal pot with a bottom, bearing members covering the longitudinal and end walls and the bottom of the pot, with lining enclosed therein and cathode blocks with cathode rods forming the cathode of the reduction cell. On the longitudinal and end walls of the metal pot in the gaps between the bearing members there are fixed plate ribs and/or finger ribs with a developed structure for heat removal, with a belt made of composite material for steady heat removal installed in the upper part of the longitudinal and end walls of the metal pot. The cooling effect is achieved by a convective air flow caused by the lifting force resulting from the air heating in the space between the ribs at the melt level and the resulting temperature difference along the height of the cathode casing walls.

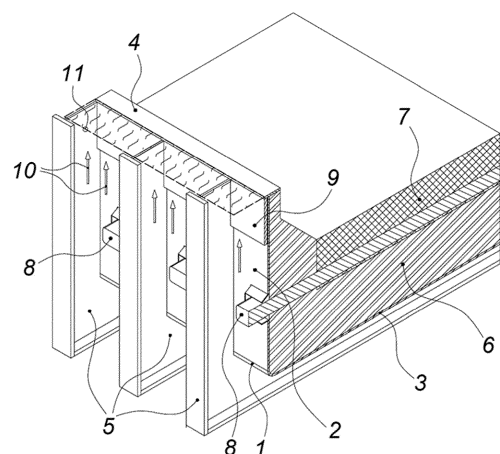


Fig. 1

Description

Technical field of the invention

[0001] This invention pertains to aluminium production via electrolysis of molten salts, particularly to the cathode assembly of a reduction cell, and explores the assembly of the upper belt of the longitudinal and end walls of the cathode shell.

Prior art

[0002] A cathode assembly is usually an assembly that comprises a cathode shell and an internal lining, which enables electrolysis to occur within a cryolite-alumina melt (also known as bath).

[0003] The cathode shell consists of a metal pot including longitudinal and end walls, with base and bearing members (shell stiffening rods, counterforce cradles, and beams, among others), which cover the pot's walls and base, and are typically constructed from steel. The cathode shell is lined inside with lining materials (refractory and heat-insulating bricks, carbide-silicon plates and carbon-graphite cathode blocks with steel cathode rods, etc.).

[0004] The cathode shell is engineered to protect the internal lining from any distortions or damage caused by forces generated within the cathode assembly while the reduction cell is in operation. Therefore, it must have the necessary mechanical strength and stiffness to ensure a long service life of the cathode assembly.

[0005] Another important function of the cathode shell is to ensure intensive heat removal from the electrolysis process area and dissipation of excess heat into the environment. This contributes to the formation of a layer of solidified cryolite-alumina melt/scale on the inner lined (side) walls of the cathode assembly, which protects them from the effects of aggressive environment and high temperature (within 870-970 °C), thus providing optimal conditions for the electrolytic reduction and protect the side walls from the aggressive effects of bath and electrolytic reduction products.

[0006] Therefore, by creating the right conditions for intensive cooling of the cathode shell, three problems can be solved:

- to protect the side walls against wear and tear and to ensure a long service life of the side walls,
- to intensify the process of electrolytic aluminium production by increasing the unit capacity of the reduction cell,
- increase the efficiency of reduction cell operation by controlled regulation of temperature conditions.

[0007] A method of cooling an aluminium reduction cell (US 4087345, C25C 3/08, May 2, 1978) containing a cathode shell in the form of a steel pot including vertical (longitudinal and end) walls with a bottom is known. Ver-

tical stiffeners (T-beams and/or I-beams) are attached to the walls at certain intervals along the length and width of the shell. The beams have good thermal contact with the walls of the steel pot. The walls of the steel pot are encompassed by horizontal stiffeners (T-beams and/or I-beams) all around the outer perimeter, forming a single rigid structure. In some modifications, the walls may be additionally covered by bearing members (shell stiffening rods, counterforce cradles).

[0008] Thus, along the perimeter of the cathode shell between the vertical stiffeners, vertical walls of the pot and horizontal stiffeners, vertical air corridors are formed designed for unobstructed passage of air to remove and dissipate heat from the shell walls and vertical stiffeners of the structure.

[0009] The shell walls are cooled by a convective air flow caused by the lifting (Archimedes') force resulting from the air heating in the upper parts (at the melt level) of the vertical air corridors and the resulting temperature difference along the height of the shell walls. This makes it possible to increase heat removal by the vertical side walls of the shell and reduce the temperature of the shell walls, thus creating conditions for the formation of a layer of solidified cryolite-alumina melt/scale on the inner lined walls of the cathode assembly.

[0010] The primary shortcoming of the existing method lies in the low efficacy of heat removal and dissipation from the cathode shell due to the limited cooling area and low velocities of convective air flow. Consequently, in this situation, applying a stable and sufficiently thick layer of scale on the inner surface of the side lining becomes problematic. Lack of scale usually results in intensive wear of the side lining, which adversely impacts the service life of the reduction cell.

[0011] A cathode assembly of an aluminium reduction cell (RU 2230834, C25C 3/08, June 20, 2004) is known, equipped with a cathode shell, including a metal pot lined from the inside, with longitudinal and end walls and bottom, installed inside a rigid frame formed by transverse shell stiffening rods (bearing members). The end walls of the pot are reinforced with stiffening belts formed by vertical and horizontal stiffeners connected with each other by a strapping (bending) sheet. In this case, the horizontal stiffeners are placed at some distance in the horizontal plane from the vertical end wall, in such a way that vertical air corridors are formed between them with the width of 1/3 to 2/3 of the distance from the end wall of the pot to the strapping sheet, which are intended for the flow of air cooling the shell. Additionally, between the vertical stiffening ribs there are vertical steel cooling ribs in the amount of 1-4 pcs. and the height equal to the height of the side lining, preferably the dimensions of the ribs are as follows: thickness 6-8 mm, height 640-650 mm, width 120 mm.

[0012] The known method enables air flow along vertical air corridors through cooling ribs welded to the wall to remove and dissipate heat from the end walls of the cathode shell by natural convective heat exchange with

the environment.

[0013] The primary shortcoming of the known solution is that it is proposed to install cooling ribs only on the end walls of the cathode shell, as a result of which heat will be removed more intensively only from the ends of the cathode shell, while the problem with the cooling of the longitudinal walls remains. Another shortcoming of this solution is the low efficiency of heat removal from the end wall of the cathode shell, because the heat transfer coefficient increases insignificantly (from about 15 to 25 W/m²·K). This is explained by the presence of a solid flange sheet preventing the free air flow and relatively low thermal conductivity of cooling ribs made of St3 steel with a coefficient of thermal conductivity of 50 W/m·K at 300 °C), so the heat transfer by the ribs is inefficient.

[0014] A method of cooling a reduction cell for aluminium production is known (US 4608134, C25C 3/08, August 26, 1986), containing an external cathode shell, made in the form of a steel pot, with lining enclosed inside it, consisting of refractory and heat-insulating lining materials and carbon-graphite cathode blocks and located on the inner part of the side walls of the cathode shell side part of the lining (carbon-graphite or silicon carbide plates). Along the sides of the cathode assembly at the melt level, between the inner surface of the cathode shell and the outer wall of the side part of the lining, there are air cavities, which communicate with inlets for air intake and outlets equipped with air flow control valves. Cooling takes place as follows: cold air drawn from the environment at the sides of the reduction cell is drawn in through the inlets and directed into the air cavities along the side lining, resulting in its cooling, while the hot air flow rate is controlled through the outlets fitted with valves. Thus, by adjusting the hot air flow rate, the formation of the scale on the sides of the cathode assembly can be controlled.

[0015] The main shortcoming of the known solution is the necessity of significant modification of the cathode assembly of the reduction cell to place cooling tubes (coils), pumping large volumes of coolant (air) through the tubes and placement of additional infrastructure designed for pumping coolant (air). All of this entails significant financial costs.

[0016] In addition, it is necessary to solve the problem of protecting the side lining from oxidation by the oxygen of the air drawn in from outside or, if the inboard liner is insulated with an oxidation-resistant material (e.g. steel), to ensure good thermal contact between this material and the lining.

[0017] Another shortcoming of this solution is the necessity of removing a large amount of heated gas-air mixture (exhaust gases and air) from under the reduction cell hood, due to the intake of a large amount of air from the environment used for cooling, and its release into the hood. This entails an increase in the capacity of smoke extraction and gas treatment plants.

[0018] A reduction cell for aluminium production is known (SU 605865, C25C 3/08, May 5, 1978), including

a metal cathode shell in the form of a steel pot, lined from the inside, the bottom and vertical walls of which are provided with box sections made in the form of airtight cavities. Heat shields made of individual plates are installed in the airtight cavities, and air lines with air distribution valves are connected to them, into which air is blown by a fan or compressor.

[0019] The shortcoming of the known solution is the necessity of creating a complex and cumbersome network of air lines, which significantly clutter the space around the reduction cell, while the high noise level created by the air blown into the airtight cavities or into the atmosphere of the enclosure creates unfavourable conditions for the operating staff. In addition, due to the low heat capacity of air, a substantial air flow rate is required for effective heat removal, thus requiring a compressor station or powerful fans, and therefore not economically feasible.

[0020] The closest to the proposed invention in terms of technical essence and achieved result is the design of the cathode assembly of the aluminium reduction cell according to the patent RU 2321682, C25C 3/08, April 10, 2008. The assembly comprises a metal pot with a bottom and bearing members covering the walls and bottom of the bath, forming a cathode shell. Inside the cathode shell is the lining and cathode blocks with cathode rods that form the reduction cell cathode. On the longitudinal and end walls of the metal pot in the gaps between the bearing members there are fixed plate ribs made of material with high thermal conductivity. The area of one plate rib is 0.03-0.3 m². The plate rib is fastened to the metal pot using aluminium-steel or copper-steel bimetallic adapters made by explosion welding. The steel part of the bimetallic adapter is welded to the walls of the metal pot, and to the aluminium or copper part, plate ribs are welded made of aluminium or aluminium alloy or copper or copper alloy, respectively. Regulators designed as pivoting flaps, which control the efficiency of heat removal from the pot walls, are positioned in the upper section of the bearing members. In the gap between the bearing members there is installed a device for forced cooling of the plate ribs in the form of a fan and a blower. The device makes it possible to intensify the process of electrolytic aluminium production in an aluminium reduction cell by regulating the efficiency of heat removal, to provide conditions for a stable production process and to increase the service life of the cathode assembly of an aluminium reduction cell.

[0021] The known cathode assembly makes it possible to provide effective heat removal from the reduction cell to the pot side walls and further to the plate ribs, which are cooled by convective heat exchange during air flow caused by the air heating in the space between the ribs and the temperature difference along the height of the pot walls. This makes it possible under conditions of intensive operation of the aluminium reduction cell to ensure formation of a stable layer of solidified bath (scale) on the inner surface of the side lining of the cathode as-

sembly, thus increasing the service life of the cathode assembly of the aluminium reduction cell.

[0022] The shortcoming of the cathode assembly in the prototype is that in conditions of an intensive reduction process, a necessary condition for increasing the production efficiency is to ensure the ability to operate the reduction cell with a high temperature of the bath overheating (the difference between the operating temperature and the liquidus temperature) to avoid dross deposition and the formation of crusts on the bottom that decreases the process efficiency and causes related drawbacks. Therefore, the main task is to create a layer of protective scale at overheating above 25 °C (optimally about 40 °C), while the known solution can guarantee scale formation only at overheating of about 20 °C. This is because this design provides efficient heat transfer from the reduction cell to the side walls of the pot, while heat dissipation from the outer surface of the shell and, accordingly, plate ribs is not effective enough for the production process.

[0023] Generally, ribs are made of aluminium or aluminium alloy, copper or copper alloy, or special steel, i.e. a material with high thermal conductivity. The plate ribs are attached with their ends to the longitudinal and end walls of the metal pot through a bimetallic adapter made by explosion welding or by bolted and/or riveted connection.

[0024] If a bimetallic adapter is used, too many layers with low thermal conductivity are present: the wall of the metal pot is 12-30 mm of steel, plus the steel part of the bimetallic adapter is 24-35 mm, which is a total of about 36-65 mm of steel with a thermal conductivity of about 50 W/m·K ($W/m \cdot K = W/m \cdot ^\circ C$) at 300 °C. In addition, the plate ribs are fixed by means of a welded joint, i.e. the heat is only transferred through the weld leg instead of the entire cross-section of the bimetallic adapter. This ensures a minimum temperature difference of about 30-50 °C.

[0025] In the case of bolted or riveted joints, the thermal resistance between the rib and the metal pot wall is too high; if the split joint is not constantly tightened, it will loosen as a result of temperature fluctuations.

Invention disclosure

[0026] The task of the proposed invention is to develop a design of a cathode assembly for an aluminium reduction cell with increased heat dissipation from the upper part of the metal pot sides, capable of operating at overheating above 25 °C.

[0027] The technical result is the solution of the problem, more intensive production of aluminium by reduction (increasing the unit current) in an aluminium reduction cell due to the design of a cathode assembly capable of removing and dissipating the heat energy released in the reduction cell.

[0028] The problem is solved and the technical result is achieved by that in the cathode assembly of a reduction

cell for aluminium production, containing a metal pot (1) with a bottom (3), bearing members (5) covering the walls (2) and bottom of the pot, with lining (6) enclosed therein and cathode blocks (7) with cathode rods (8) forming the cathode of the reduction cell, according to the proposed invention, on the longitudinal and end walls (2) of the metal pot (1) in the gaps between the bearing members (5) there are fixed plate ribs (15) and/or finger ribs (16) with a developed structure for heat removal, made of material with high thermal conductivity, with a belt (9) made of composite material installed in the upper part of the longitudinal and end walls (2) of the metal pot.

[0029] The invention is supplemented by its particular embodiments that contribute to the achievement of the technical result.

[0030] The belt composite material may comprise at least two metal layers, wherein the overall height of the belt is 0.2-0.5 m. If the height is less than 0.2 m, insufficient heat will be removed and dissipated from the belt and the solution will be ineffective. If the height is greater than 0.5 m, the heat removal becomes excessive and as a result cooling will affect the metal area (liquid aluminium), which will negatively impact the reduction process.

[0031] The upper layer (13) of the belt composite material is made of a metal with high thermal conductivity. The upper layer (13) of the belt composite material may be made of aluminium or aluminium alloys. The upper layer (13) of the belt composite material may be made of copper or copper alloys.

[0032] The belt composite material is made by joining metal layers by pulse welding. The belt composite material may comprise an intermediate layer (14) made of titanium.

[0033] In our case we use a belt made of several layers of metal, which differ in chemical composition and are separated by a pronounced boundary.

[0034] Heat removal regulators (17) designed as pivoting flaps (18) may be installed above the bearing members.

[0035] In this case, a self-regulating system is provided for. Heat removal is regulated by increasing and decreasing the scale thickness. However, in case undesirable deviations in the operation of the device are observed, forced cooling elements (devices) can be provided for. Forced cooling devices, such as fans, may be arranged in the gaps between the bearing members (5).

[0036] The described design of the cathode assembly makes it possible to ensure effective heat removal from the reduction cell to the pot side walls and effectively dissipate heat energy by convective heat exchange during air flow caused by the air heating in the space between the ribs and the temperature difference along the height of the pot walls. This makes it possible under conditions of intensive operation of the aluminium reduction cell to ensure formation of a stable layer of solidified bath (scale) on the inner surface of the side lining of the cathode assembly at overheating above 25 °C and to guarantee stable and steady operation of the aluminium reduction

cell.

[0037] It is known that it is possible to ensure the operation of the device at overheating of up to 25 °C by simple methods, and above 25 °C it is incredibly difficult, as the protective scales comes off the side wall lining, and the walls begin to rapidly deteriorate (oxidise).

[0038] Technical experts also know that high thermal conductivity (for metals) starts from $\lambda = 60 \text{ W/m}\cdot\text{K}$.

[0039] The invention is supplemented by special cases directed to the problem at hand.

[0040] The cathode assembly is supplemented by that the composite material is made by pulse welding, the compounds obtained are steel/aluminium, steel/copper, and in the case of a titanium (Ti) interlayer, they are steel/titanium/aluminium, steel/titanium/copper. The titanium layer in composite walls is necessary for operation of the side walls at temperatures above 300 °C to avoid the formation of intermetallides at the boundary of two metals joined by the pulse and degradation of this compound.

[0041] To increase the efficiency of the cathode assembly, the outer layer of the composite material is made of a metal with a high thermal conductivity coefficient, such as aluminium, copper, bronze or special steel. For example, aluminium grades A0-A85 ($\lambda = 210\text{-}230 \text{ W/m}\cdot\text{K}$, $\text{W/m}\cdot\text{K} = \text{W/m}\cdot^\circ\text{C}$) or aluminium alloy (AD0, AD1, AD31, AD33, AD35, D1, D16, AK7, AK9, AK12, AMz, AMts, AMtsS, AMg3, AMg4, AMg5, AMg6, B63, B93, B94, B95) with thermal conductivity coefficients of approx. $\lambda = 110\text{-}230 \text{ W/m}\cdot\text{K}$; copper $\lambda = 360\text{-}390 \text{ W/m}\cdot\text{K}$ or copper alloy (bronze, brass, etc.) with thermal conductivity coefficient of approx. 70 to 380 W/m·K; special steels (55, 60, 65, 70, 20G, 30G, 40G, etc.) with thermal conductivity coefficient of approx. 50-80 W/m·K.

[0042] For more effective heat dissipation from the surface of the upper belt made of composite material, plate ribs made of material with high coefficient of thermal conductivity (aluminium, copper, bronze or special steel) are fixed on it in the amount of 3-10 pieces and with the area of 0,03-0,6 m².

[0043] The cathode assembly is supplemented in that to further improve efficiency, the plate ribs may be replaced by fingers (may be in the form of rods, bars, "sticks", etc.) having a much more developed surface for heat dissipation.

[0044] The cathode assembly is supplemented by that in the upper part of the bearing members there are installed regulators of the efficiency of heat removal from the walls of the metal pot designed as pivoting flaps, which make it possible to adjust the scale thickness or adjust its shape depending on seasonal changes in ambient temperature.

[0045] The cathode assembly is supplemented by that a forced cooling device in the form of a fan and a blower is located in the gap between the bearing members.

[0046] *The essence of the invention is explained by the following drawings.*

Fig. 1 shows a proposed cathode assembly for an aluminium reduction cell.

Fig. 2 shows a cathode assembly with the upper part of the metal pot wall of a composite material made by a process such as pulse welding. Also, Fig. 2 shows a cathode assembly with the upper part of the metal pot wall of composite material, the outer layer of which is made of metal with high thermal conductivity.

Fig. 3 shows a cathode assembly having the upper part of the metal pot wall of a composite material, the outer surface of which has a developed surface due to the installation of plate ribs.

Fig. 4 shows a cathode assembly having the upper part of the metal pot wall of a composite material, the outer surface of which has a developed surface due to the installation of finger ribs.

Fig. 5 shows a cathode assembly with the upper part of the metal pot wall of composite material, which has regulators designed as pivoting flaps, which control the efficiency of heat removal from the metal pot walls, installed in the upper section of the bearing members.

Fig. 6 shows a cathode assembly with the upper part of the metal pot wall of composite material, which has a forced cooling device in the gap between the bearing members.

[0047] The cathode assembly of an aluminium reduction cell includes a metal pot 1 having longitudinal and end walls 2, bottom 3 and flange sheet 4; bearing members 5 covering the walls and bottom of the pot; lining 6 enclosed inside the pot 1, cathode blocks 7 with cathode rods 8 forming the cathode of the reduction cell; upper belt 9 made of composite material.

[0048] The air flow 10 passing through the aperture 11 limited by the bearing members 5, longitudinal and end walls 2 flows over (cools) the upper belt 9 made of composite material. The flow 10 is created by the lifting (Archimedes') force due to its heating in the space limited by the bearing members 5, as well as by the flow of air due to the difference in its temperature along the height of the walls of the pot 2.

[0049] As in the prototype, the metal pot 1 with longitudinal and end walls 2, bottom 3 and flange sheet 4 and bearing members 5 comprising the cathode assembly also participate in the heat exchange.

[0050] Composite material is made by pulse welding, that is pressure welding in which workpieces are welded when they collide with each other due to the detonation of a pyrocharge.

[0051] A movable workpiece, which is the upper layer 13 (of a metal different from the base in physical properties, usually softer and less strong) is welded to the base 12 (a fixed steel workpiece). To preserve thermal and mechanical characteristics of the upper belt 9 of composite material in the conditions of operation at elevated temperatures, an intermediate (barrier) layer 14 of Ti (ti-

tanium) 0.5-1.5 mm thick is placed at the interface (flat or dovetail type) to prevent the formation of brittle intermetallides. Thus, effective heat removal from the upper belt 9 of the composite material with the upper layer 13 is carried out.

[0052] When the upper layer 13 of the belt 9 is made of a metal having high thermal conductivity, aluminium, copper, bronze or special steel may be used as such metals.

[0053] To improve efficiency, the surface of the upper layer 13 may be developed by installing plate ribs 15 made of a metal with high thermal conductivity, which are fixed by welding, brazing or other mechanical means (bolted and/or riveted) and by having previously made a flat surface 13 by milling or installing a spacer, for example made of a fusible heat conducting material, graphite or silver-based thermal paste, aluminium foil, refractory cement, etc., which will level the uneven surface of the wall.

[0054] Further increase of efficiency is possible due to even greater development of the surface 13 by installing finger ribs 16 made of a metal with high thermal conductivity making it possible to increase the heat-removing surface by 20-30% and ensure heat energy dissipation.

[0055] To regulate heat removal from the upper part of the walls of the pot (belt) 9 of composite material, heat removal regulators 17 designed as pivoting flaps 18, can be installed in the aperture 11 above the bearing members 5 to change the open area in the aperture 11. This makes it possible to adjust the scale thickness depending on seasonal changes in the ambient temperature and changes in the reduction cell current.

[0056] To increase the intensity of heat removal from the cathode assembly, and in particular by reducing the surface temperatures of the upper belt 9 of the metal pot 1, a forced cooling device 19 may be installed in the gap between the bearing members 5. The device is, for example, a centrifugal fan with a capacity of 1000-2000 m³/h. The heat dissipation can thus be increased by a further 30-50%.

Embodiment of invention

[0057] Mounting and dismounting of the cathode assembly of the aluminium reduction cell is carried out as follows.

[0058] When manufacturing the cathode assembly of the proposed design, in which intensive heat removal from the pot and its dissipation by the upper belt 9 of a composite material guarantees the formation of a stable layer of solidified bath (scale) on the inner surface of the side lining of the cathode assembly at overheating above 25 °C and, accordingly, ensures stable and steady operation of the aluminium reduction cell.

[0059] The bottom 3, flange sheet 4 and longitudinal and end walls 2 of the metal pot 1 are made of 12-20 mm thick sheet steel of sufficient ductility and quality. Inside the metal pot 1, lining 6 is placed consisting of refractory

and heat-insulating materials, and cathode blocks 7 with cathode rods 8 installed in them.

[0060] Bearing members 5 covering the walls and bottom of the pot 1 are made in the form of either shell stiffening rods (T- or I-beams) or hinged counterforce cradles (a structure with a box cross-section or two I-beams welded together). In the upper part of the longitudinal and end walls a belt 9 made of composite material consisting of 2 or more layers of different metals with a height of 0.2-0.5 m is installed. The lower part of the belt is welded to the walls 2, the upper part of the belt is welded to the flange sheet 4, and the upper layer 13 surface is either welded to the bearing members 5 or rests in them, ensuring free contact.

[0061] The belt 9 is manufactured of composite material separately. Pulse welding is a mechanical type of pressure welding in which the joint is made by the explosion-induced collision of the parts to be welded. The composite belt material comprises typically a steel base 12, an upper layer 13 of high thermal conductivity material and an intermediate layer 14 of titanium. The intermediate layer 14 is required to be installed when the belt is operated in the device at temperatures greater than 300 °C.

[0062] The greatest efficiency is achieved when the upper layer 13 of the belt 9 of composite material has a developed surface, which is achieved by inserting plate ribs 15 and/or finger ribs 16 made of a highly thermally conductive material such as special steel, aluminium or aluminium alloy, copper or copper alloy. The plate rib 15 is made in the form of a rectangle or trapezoid with a height of 300-600 mm, a width of 100-500 mm and a thickness of 6-10 mm. The number of ribs is selected based on the required heat transfer coefficient. For example, the installation of 7 ribs from St3 steel 6 mm thick with an area of 0.3 m² with a distance of 50 mm between the ribs resulted in a heat transfer coefficient $\alpha_n = 75$ W/m²·K in the free convection mode. For comparison, without plate ribs, the maximum possible heat transfer coefficient is $\alpha_n = 30$ W/m²·K. Installing 7 plate ribs made of aluminium grade A5 with a thickness of 10 mm and area of 0.3 m² with a distance of 50 mm between the fins resulted in a heat transfer coefficient of approx. $\alpha_n = 150$ W/m²·K.

[0063] These values of heat transfer coefficients were obtained on a heat bench simulating the wall of the metal pot of the reduction cell cathode assembly in experimental studies of different variations of plate ribs.

[0064] Replacing the plate ribs 15 with finger ribs 16 increases the heat transfer surface by 20-30% and makes it possible to increase the heat transfer coefficient by 15-20%.

[0065] If it is not necessary to dissipate such amount of heat, the heat dissipation coefficient can be reduced by closing the pivoting flaps 18 of the heat removal regulators 17.

[0066] When it is necessary to increase the amount of heat dissipated from the cathode assembly, forced cool-

ing devices 19 in the form of a fan and blower may be used, as well as other suitable cooling devices.

[0067] Thus, the proposed cathode assembly can provide a stable layer of solidified bath (scale) on the inner surface of the side lining of the cathode assembly at overheating above 25 °C and guarantee stable and steady operation of the aluminium reduction cell. For example, the test sample was operated at overheating of 40 °C, in summer (the worst conditions) and there was a minimum layer of protective scale on the walls.

Claims

1. A cathode assembly of a reduction cell for aluminium production, containing a metal pot (1) with a bottom (3), bearing members (5) covering the longitudinal and end walls (2) and bottom of the pot, with lining (6) enclosed therein and cathode blocks (7) with cathode rods (8) forming the cathode of the reduction cell, **characterised in that** on the longitudinal and end walls (2) of the metal pot (1) in the gaps between the bearing members (5) there are fixed plate ribs (15) and/or finger ribs (16) with a developed structure for heat removal, with a belt (9) for steady heat removal made of composite material installed in the upper part of the longitudinal and end walls (2) of the metal pot. 15
2. The cathode assembly of claim 1, **characterised in that** the composite material of the belt consists of at least two metal layers, wherein the height of the belt is preferably 0.2-0.5 m. 20
3. The cathode assembly of claim 2, **characterised in that** the top layer (13) of the belt composite material is made of a metal with high thermal conductivity, preferably above 60 W/m·K. 25
4. The cathode assembly of claim 2 or claim 3, **characterised in that** the top layer (13) of the belt composite material is made of aluminium or aluminium alloys. 30
5. The cathode assembly of claim 2 or claim 3, **characterised in that** the top layer (13) of the belt composite material is made of copper or copper alloys. 35
6. The cathode assembly of any one of claims 2 to 5, **characterised in that** the belt composite material is made by joining the metal layers by pulse welding. 40
7. The cathode assembly of claim 2, **characterised in that** the belt composite material comprises an intermediate layer (14) made of titanium. 45
8. The cathode assembly of claim 1, **characterised in that** heat removal regulators (17), preferably de-

signed as pivoting flaps (18), are installed above the bearing members (5).

9. The cathode assembly of claim 1, **characterised in that** forced cooling devices, in particular fans, are placed in the gaps between the bearing members (5). 5
10. The cathode assembly of claim 1, wherein the plate fins (15) and/or finger fins (16) are made of a material with a thermal conductivity above 60 W/m·K. 10

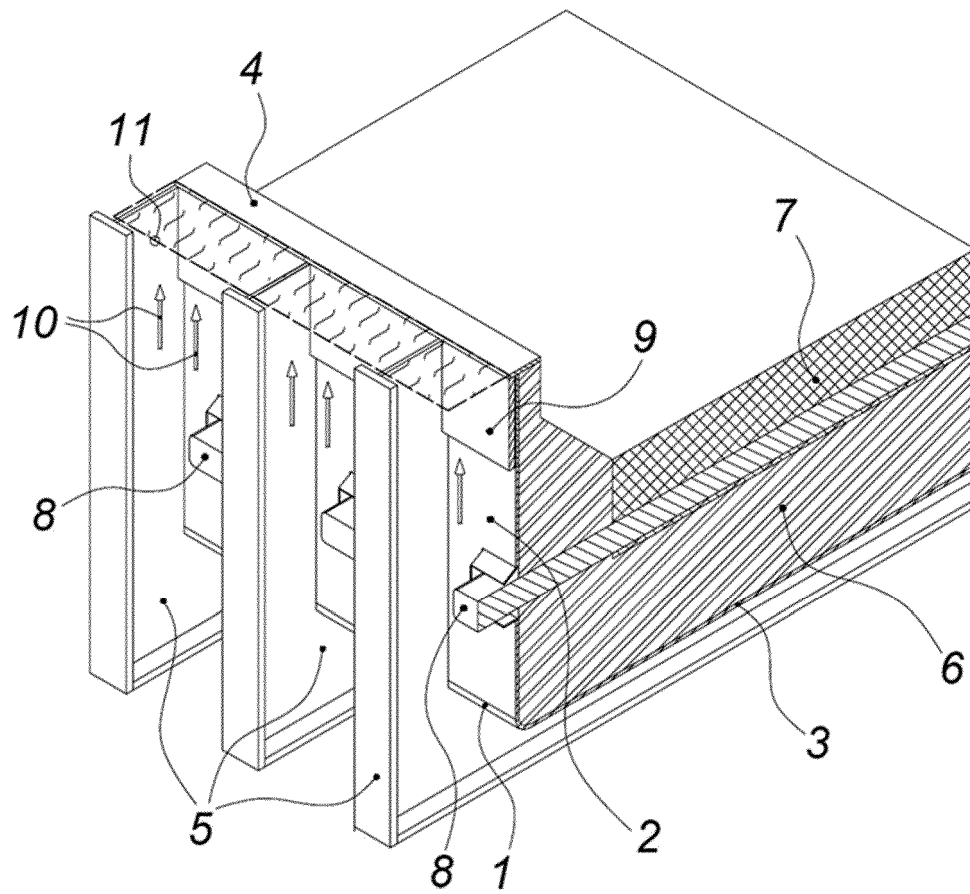


Fig. 1

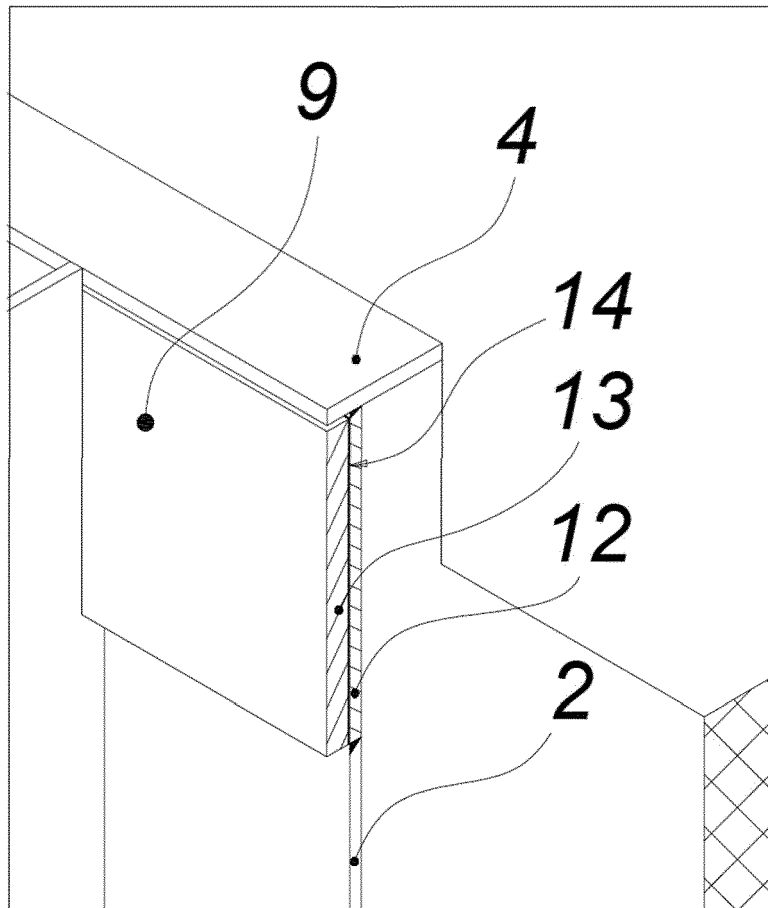


Fig. 2

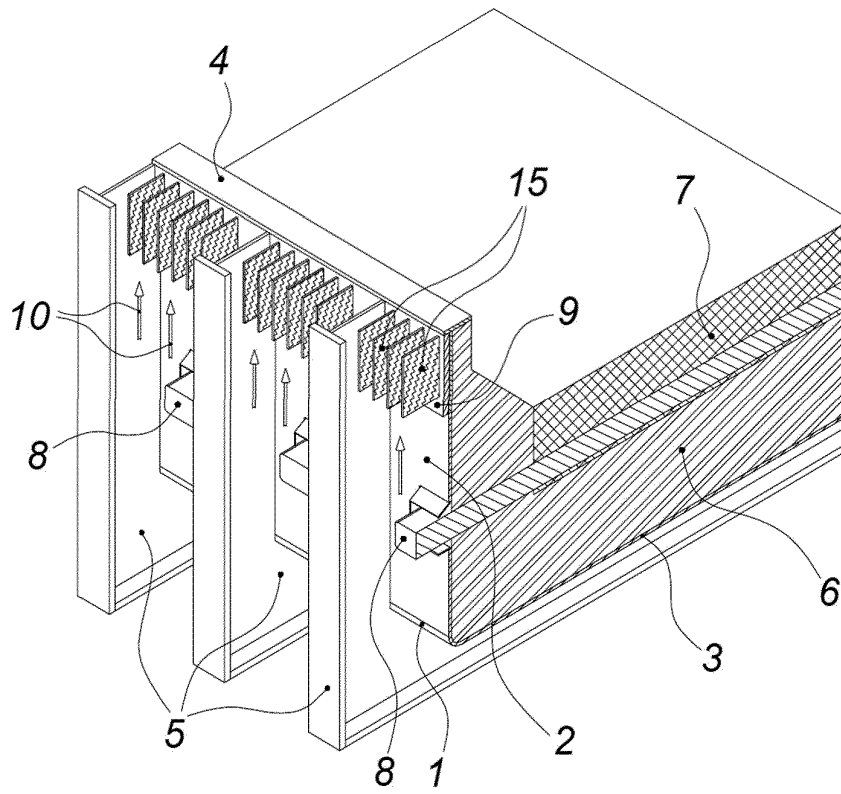


Fig. 3

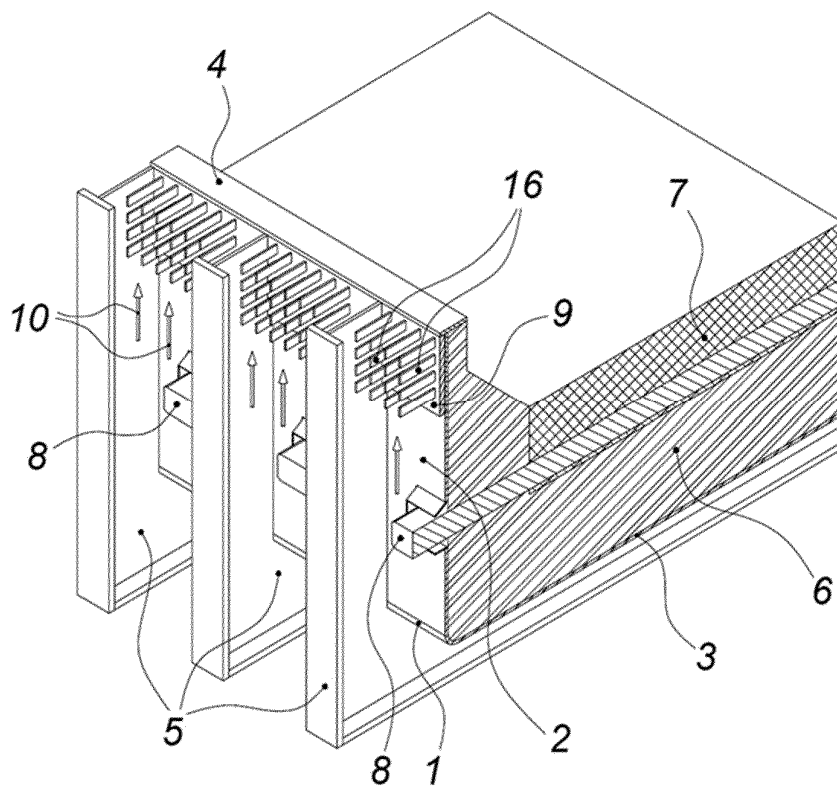


Fig. 4

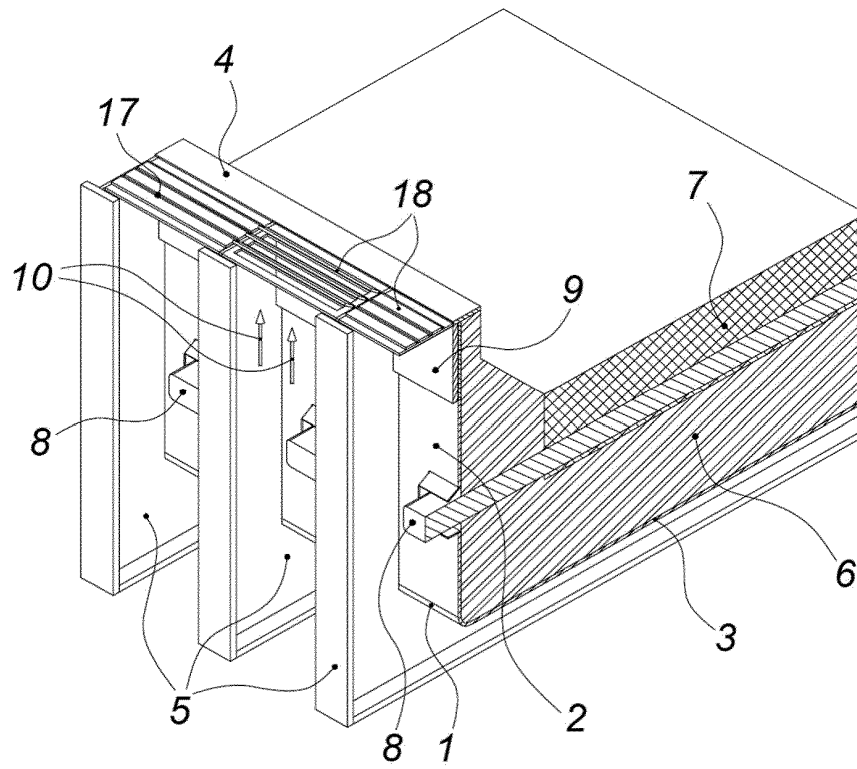


Fig. 5

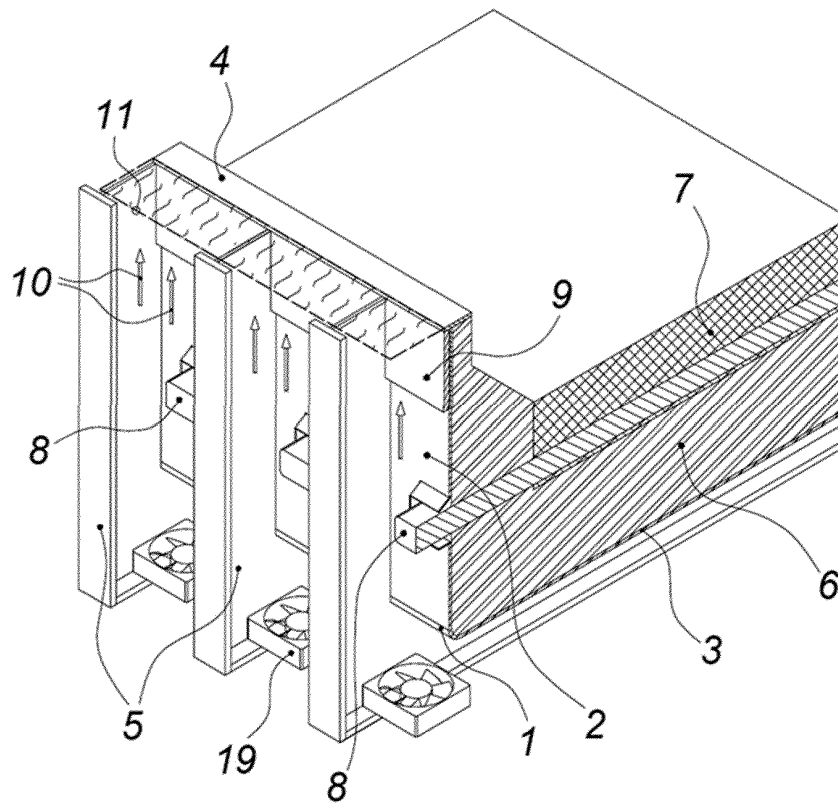


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/RU 2022/050227

A. CLASSIFICATION OF SUBJECT MATTER

C25C 3/08 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25C 3/00, 3/06, 3/08, 3/10

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

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

PatSearch (RUPTO Internal), USPTO, PAJ, Espacenet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
D, A	RU 2321682 C2 (OBSCHESTVO S OGRANICHENNOY OTVETSTVENNOST'YU "RUSSKAYA INZHINIRINGOVAYA KOMPANIYA") 10.04.2008	1-10
A	EA 010167 B1 (BIEYCHPI BILLITON INNOVEYSHN PTI LTD.) 30.06.2008	1-10
A	RU 2324008 C2 (ALYUMINIYUM PESHINE) 10.05.2008	1-10
A	US 2004/0149570 A1 (OYO TANSO CO., LTD) 05.08.2004	1-10
A	WO 2004/007806 A3 (ALUMINIUM PECHINEY et al.) 22.01.2004	1-10

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

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"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

"&" document member of the same patent family

Date of the actual completion of the international search

03 October 2022 (03.10.2022)

Date of mailing of the international search report

03 November 2022 (03.11.2022)

Name and mailing address of the ISA/RU

Authorized officer

Facsimile No.

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4087345 A [0007]
- RU 2230834 [0011]
- US 4608134 A [0014]
- SU 605865 [0018]
- RU 2321682 [0020]