



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**  
GW, ML, MR, NE, SN, TD, TG).

— with international search report (Art. 21(3))

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**(57) Abstract:** Cathode structure for an electrolysis cell, preferably a cell for production of aluminium according to the Hall-Heroult process, said structure comprises a shell with vertical stiffeners and horizontal webs at its outside, and further several cradle structures (12) consisting of interconnected vertical structural elements (6) and horizontal beams (5). The structure comprises at least one horizontal web (9) having apertures (16) and further being arranged in contact with said shell.

### Cathode shell structure

The present invention relates to a cathode structure for an aluminium electrolysis cell.

5 Electrolysis cells for aluminium production based upon the Hall-Héroult principle commonly have prebaked anodes in its upper part and a cathode structure in its lower part. The cathode structure comprises mainly an outer steel shell provided with vertical stiffeners and horizontal beams at its outside which are made out of steel too, the cathode structure further being provided with layers of protective and insulating material at its  
10 inside. In the mainly horizontal bottom part of the cathode structure there is commonly arranged electronic conducting carbon blocks. The cathode structure when in operation, contains a molten aluminium metal pad and above that molten bath material having temperatures that can be approximately 970° or even higher.

15 The main feature of the outer steel shell including its stiffeners and beams is to maintain the geometric and dimensional configuration of the cathode structure during its lifetime of operation. Due to continuous chemical swelling of the cathode and lining as well the high temperatures involved and the effect this has on the properties of lining and steel components involved, several attempts have been carried out to make the steel shell  
20 structure and the configuration of stiffeners able to withstand this influence in a long lasting manner.

For instance, appropriate cooling may relieve some of the harmful effects of the temperature in the steel shell to prevent aging of the steel and collapsing of mechanical  
25 properties like strength, elasticity, etc. In the prior art there are examples of arrangements for natural cooling by designing the stiffening structure in a manner that allows surrounding air to pass close to the shell structure.

US 4087345 disclose a cathode structure designed to be cooled by natural cooling and  
30 where there are arranged ducts or passages between vertical stiffeners outside the cathode shell for allowing an upward draught of air. Horizontal beams arranged as a part of the stiffening structure are arranged onto the outside of the vertical stiffeners.

Due to the high thermal loads in modern electrolysis cells with amperages approaching  
35 400 kA or even more, thermal expansion and twisting or torsion based deviation of the vertical members may cause insufficient structural stability of the steel shell.

US 4,322,282 disclose a tank for an electrolytic cell provided with horizontal movable hollow sections secured to the sidewalls of the metal tank. The sections bend inwards as a result of the temperature gradient across them such that they counter a pressure on the sidewalls due to the dilation of the cell contents, thus acting as a thermo-spring. There is provided holes in opposing horizontal walls of the hollow section so as to reduce thermal conduction within the sections and thereby maintain the temperature gradient therein. The circulation of air which results, helps further to achieve and maintain the temperature difference.

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However, due to the rather small holes placed in the two opposing horizontal walls, the hollow section will restrict heavily the natural upward draught along the steel shell. Simulations show that flow inside the hollow section will be partly vertical and partly circulating, resulting in less heat transport from the hollow section. In particular, flow close to the shell will be partly directed downward and give scarce cooling in this region. This is further illustrated in Fig. 3.

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In accordance to the present invention, at least one horizontal web is arranged in contact with the steel shell without intermediate vertical members that may, as a result of thermal loads, alter their geometric configuration. To reduce or eliminate the negative effect of arranging horizontal webs in direct contact with the steel plates (shell), there are made provisions for adequate cooling of these webs and the plates itself. With the present invention there is achieved a stable and cost effective solution with regard to the negative phenomenon of ageing and geometrical/dimensional deviation in the structural components of the pot shell. The web has apertures facing the shell.

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These and further advantages can be achieved in accordance to the invention as described in the accompanying patent claims.

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In the following, the invention shall be further described by examples and figures where:

Fig. 1 discloses a three dimensional view of a quart pot shell structure without the inner walls for better visibility,

Fig. 2 discloses a three dimensional view of an end structure of the pot shell shown in Figure 1 without end wall and deck plate,

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Fig. 3 discloses air flow inside one hollow section of prior art type,

Fig. 4 discloses air flow in accordance with the present invention, through a lower and upper web.

As can be seen from Fig. 1, there is shown in a 3 D view a quart of a pot shell structure 1 where the steel plates are not shown. One half of an end wall 2 and correspondingly one half of a side wall 3 as well as a quart of a bottom 4 haven been disclosed. The end wall comprises as its main constituents a deck plate 7, vertical stiffeners 8, 8', 8'', 8''', one horizontal web 9 and a reinforcing bracing flange 10.

The side wall 3 comprises a deck plate 11, vertical structural elements 6, 6', 6'', 6''', 6''''', 6'''''' which in fact is a part of a cradle structure 12, together with corresponding horizontal beams 5, 5', 5'', 5''', 5''''', 5'''''' that are fixedly interconnected with the said vertical structural elements. Further, the side wall 3 comprises a plurality of vertical stiffeners 13, 14, 15 which additionally acts as cooling fins.

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Figure 2 discloses in a 3 D view the end wall structure 2 as partly shown in Fig. 1, here in its full extension and where the deck plate has been removed. As indicated in Fig. 1, the reinforcing bracing flange 10 represents the outermost element of the end wall structure. The bracing flange is further attached to the side walls and the vertical structural element 6'''''' of the cradle structure closest to this end. Inside the bracing flange 10 there is arranged the mainly horizontal web 9 which outer periphery fits the shape of the bracing web,

As indicated in Fig. 1, the end wall structure further comprises vertical stiffeners 8, 8', 8'', 8''', 8''''', 8'''''''. The number of stiffeners is a function of the shell width and anticipating inner forces. These stiffeners are integrated in the horizontal web 9 by any appropriate manufacturing method. For instance the web 9 can have slots adapted to the stiffeners that are subsequently fixed to the web, for instance by welding. One other method can be to manufacture the web 9 in appropriate pieces or plates that abut the stiffeners and which subsequently are fixed to the stiffeners.

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In this embodiment the vertical stiffeners are provided with a flange at their outer side. A part of such a flange is indicated at 8a' in stiffener 8'. One purpose of this flange is to enhance bending and torsion stiffness in the stiffener with regard to occurring loads. The inner side of the stiffener is fixed to the steel plate(s) of the pot shell by appropriate means, for instance welding. Similarly, the stiffeners are connected to an extension of the bottom plate of the shell (not shown), to enhance stiffness in the end wall.

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To secure sufficient ventilation along the pot shell, based upon upward draught, the horizontal web 9 is provided with several holes or apertures 16, 16', 16", 16"', 16''''', 16''''', 16''''', 16'''''. These apertures are made sufficiently wide and deep to reduce the presence of the horizontal web with regard to ventilation. Preferably the apertures are made semi-circular or semi-elliptical or polygonal and are represented by discrete cut-outs at the side edge of the web. The bridging or protruding parts of the web between neighbouring recesses, are connected to the pot shell by appropriate means, for instance welding. In the Figure 2, there can be seen vertical fins 17, 17', 17", 17"', 17''''', 17''''', 17''''', 17'''''. These fins are primary to enhance cooling of the pot shell by conductance, but additional effects are guiding the flow of air as well as additional stiffening of the pot shell plates. The fins are advantageously fixed to the pot shell by appropriate means such as welding.

15 It should be understood that the end wall structure may have two horizontal webs of the type 9 that are spaced apart (not shown).

An air flow pattern in accordance with such arrangement is shown in Fig. 3. It can clearly be seen that the air flow is directed upwards along the shell wall and through the ventilation holes or apertures of type 16.

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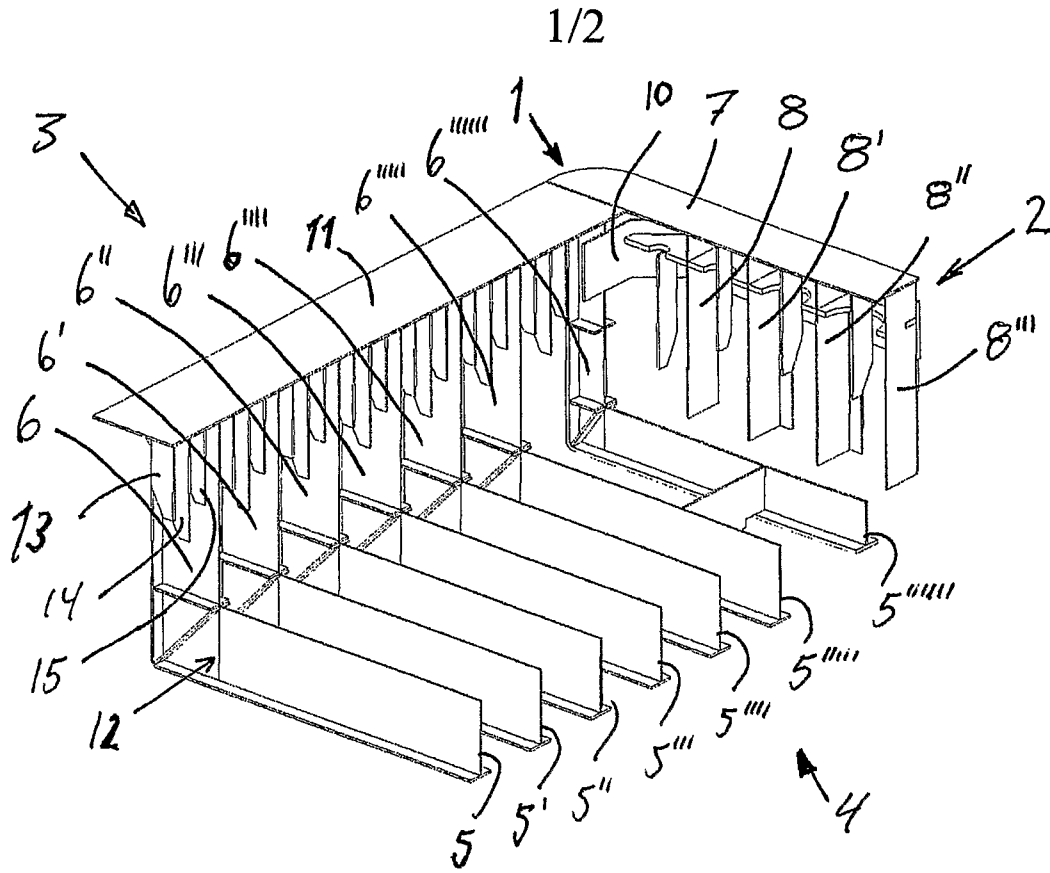
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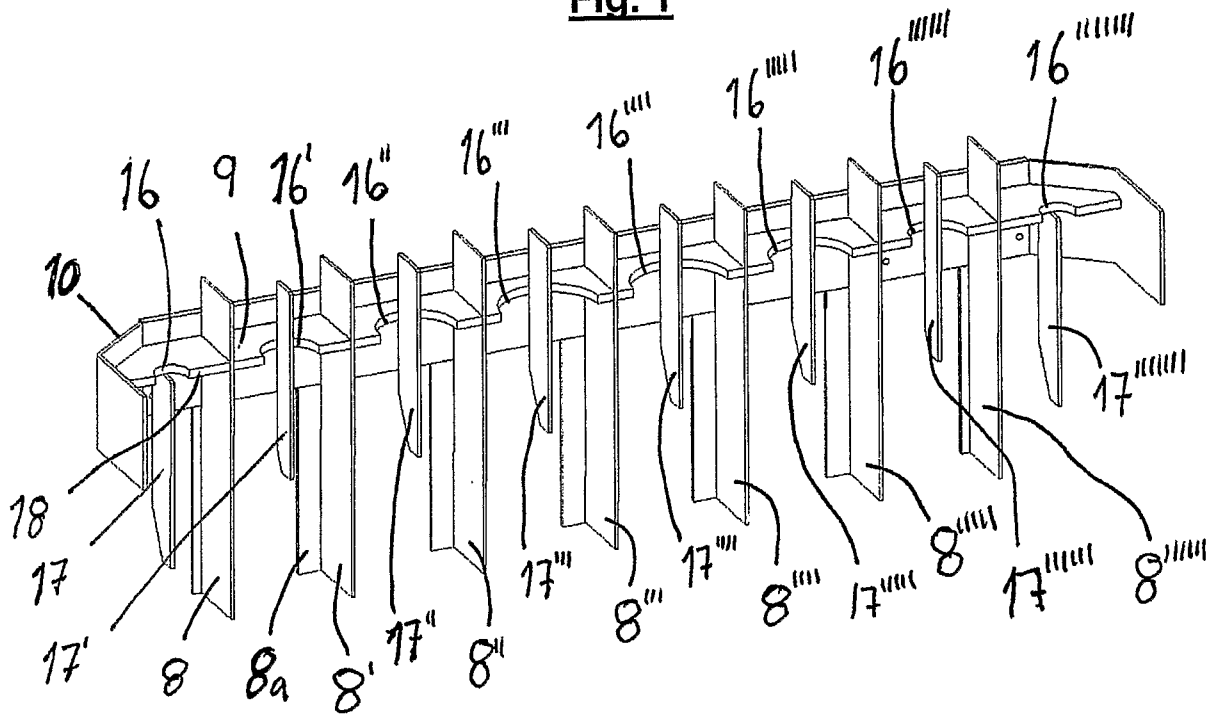
### Claims

- 5 1. Cathode structure for an electrolysis cell, preferably a cell for production of aluminium according to the Hall-Héroult process, said structure comprises a shell with vertical stiffeners (8) and horizontal webs (9) at its outside, and further several cradle structures (12) consisting of interconnected vertical structural elements (6) and horizontal beams (5),  
c h a r a c t e r i s e d i n t h a t  
10 at least one horizontal web (9) with apertures (16) is arranged in contact with said shell.
- 15 2. Cathode structure in accordance with claim 1,  
c h a r a c t e r i s e d i n t h a t  
the apertures (16) are represented by discrete cut-outs at the side edge of the web having bridging parts (18) between them, the web being connected to the shell via said bridging parts.
- 20 3. Cathode structure in accordance with claim 1,  
c h a r a c t e r i s e d i n t h a t  
the apertures (16) are semi-circular or semi-elliptical or polygonal.
- 25 4. Cathode structure in accordance with claim 1,  
c h a r a c t e r i s e d i n t h a t  
cooling fins (17) are arranged at the outside the shell and runs through the apertures (16).
- 30 5. Cathode structure in accordance with claim 1,  
c h a r a c t e r i s e d i n t h a t  
a bracing web (10) is arranged outside the horizontal web (9).
6. Cathode structure in accordance with claim 5,  
c h a r a c t e r i s e d i n t h a t  
the plane of orientation of the bracing flange (10) is mainly vertical.

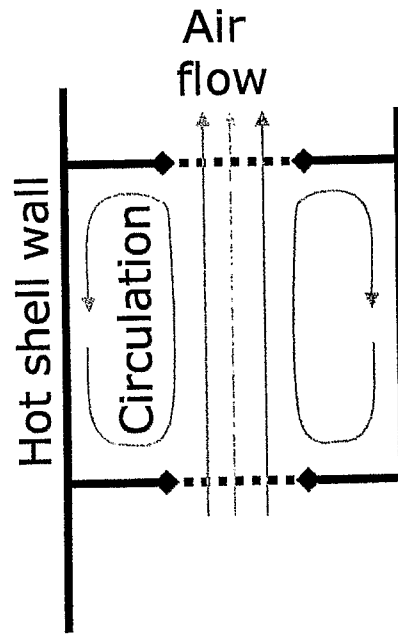
7. Cathode structure in accordance with claim 5, in particular an end wall construction thereof,  
characterised in that  
5 the bracing flange is connected to vertical structural elements (6) of a cradle (12) close to this end.
8. Cathode structure in accordance with claim 5,  
characterised in that  
10 the bottom part of the vertical stiffeners (8) are connected with an extension of the bottom plate of the shell .
9. Cathode structure in accordance with any preceding claim 1-8,  
characterised in that  
15 the structural elements are made out of steel materials.
10. Cathode structure in accordance with claim 9,  
characterised in that  
20 the said elements are connected to each other by welding.
11. Cathode structure in accordance with claim 1,  
characterised in that it  
has two horizontal webs (9).



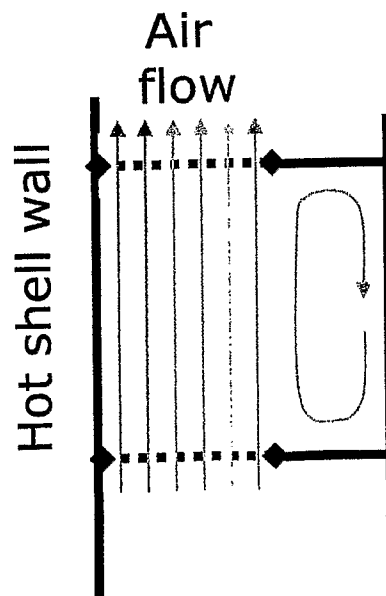
**Fig. 1**



**Fig. 2**



**Fig. 3**



**Fig. 4**

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NO2010/000327

A. CLASSIFICATION OF SUBJECT MATTER		
IPC C25C 3/10 (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		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
NO, SE, FI, DK (classes as above)		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPODOC, WPI, CAPLUS, ALUMINIUM		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	RU 2294404 C (SIBE ALUMINIUM ELECTRODE IND RES DES INS ) 2007.02.27 abstract, drawings	1-3, 5, 6, 9-11
Y		7, 8
Y	RU 2308547 C (RUSSKAYA INZH CO LTD) 2007.06.27 abstract, drawings	7
A		1-6, 8-11
Y	US 4087345 A (ARDAL OG SUNNDAL VERK) 1978.05.02 fig. 1	8
A		1-7, 9-11
X	SU 1560634 A (ZHUKOV V G) 1990.04.30, Derwent WPI/Thomson, AN 1990-374561 (English abstract) abstract, drawings	1, 5, 6, 9-11
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
2010/11/01		19/11/2010
Name and mailing address of the ISA/ Nordic Patent Institute Helgeshøj Allé, 2630 Taastrup, Denmark Facsimile No. +45 4350 8008		Authorized officer Flister, Synnøve Telephone No. +47 22387657 (direct)

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2010/000327

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SU 1669997 A (SIBTSVETMETREMONT TECHN EQUIP REPAIR) 1991.08.15, Derwent WPI/Thomson, AN 1992-240410 abstract, drawings	1, 5, 6, 9-11
X	CN 2644436 Y (ALUMINUM CORP OF CHINA LTD) 2004.09.29, EPODOC/EPO, PN CN2644436Y (English abstract) abstract, drawings	1, 5, 6, 9, 10
X	CN 201010697 Y (DESIGN & RES INST CO LTD) 2008.01.23, Derwent WPI/Thomson, AN 2008-C52501 (English abstract) abstract, drawings	1, 9, 10
A	I. Eick and D. Vogelsang, "Dimensioning of Cooling Fins for High-Amperage Reduction Cells", TMS Light Metals, (1999), 339-345	4
A	CN 1442513 A (SHENYANG ALUMINIUM MAGNESIUM INST, SHENYANG INST AL MG DESIGN) 2003.09.17 abstract, drawings	4
A	SU 549513 A (ALUM MAGN ELECTR IND) 1977.03.05, Derwent WPI/Thomson, AN 1978-01579A (English abstract) abstract, drawings	1-11

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

International application No.  
PCT/NO2010/000327

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
RU2294404 C	2007-02-27	None	
RU2308547 C	2007-10-20	None	
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