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(54) **COOLING ELEMENT FOR COOLING THE FIREPROOF LINING OF A METALLURGICAL FURNACE (AC,DC)**

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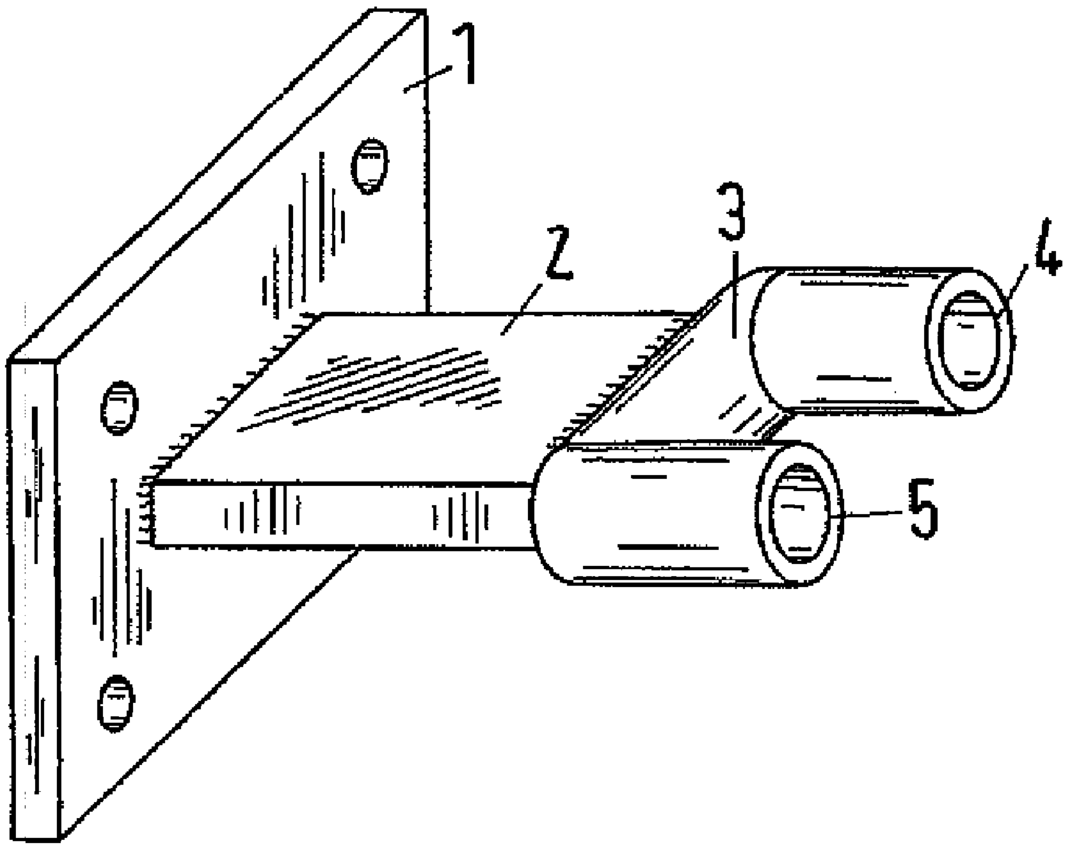
(57) **ABSTRACT**

A cooling element for cooling the refractory lining of a metallurgical furnace. A cooling element is to be provided which prevents coolant from entering the interior of the furnace while maintaining a good cooling action. This is achieved by a cooling plate which faces the refractory lining, a heat-conducting plate which is arranged at an angle to the latter, which is fixedly connected to the cooling plate and extends out of the furnace wall. The cooling plate and the heat-conducting plate are made of solid material. A coolant channel which is fixedly connected to the heat-conducting plate is connected to a coolant input and a coolant output.



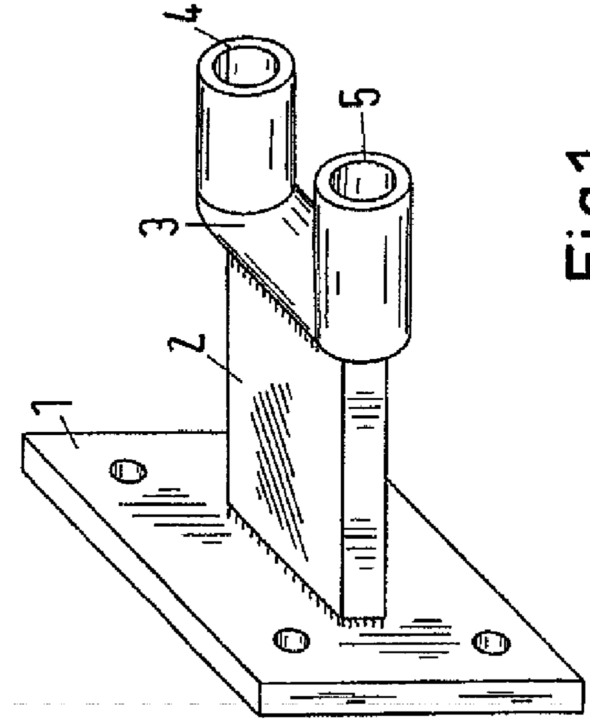


Fig.1

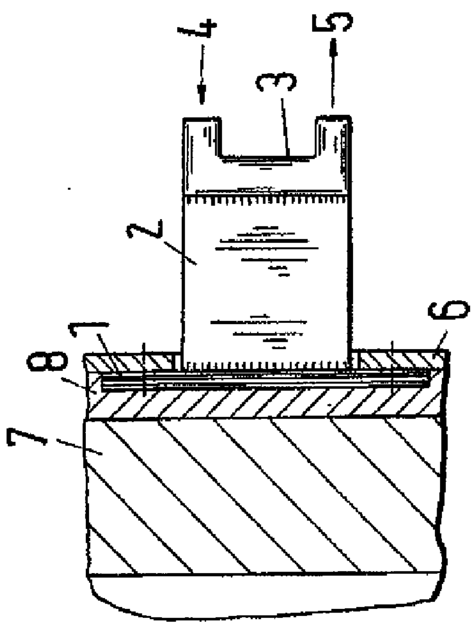


Fig.2

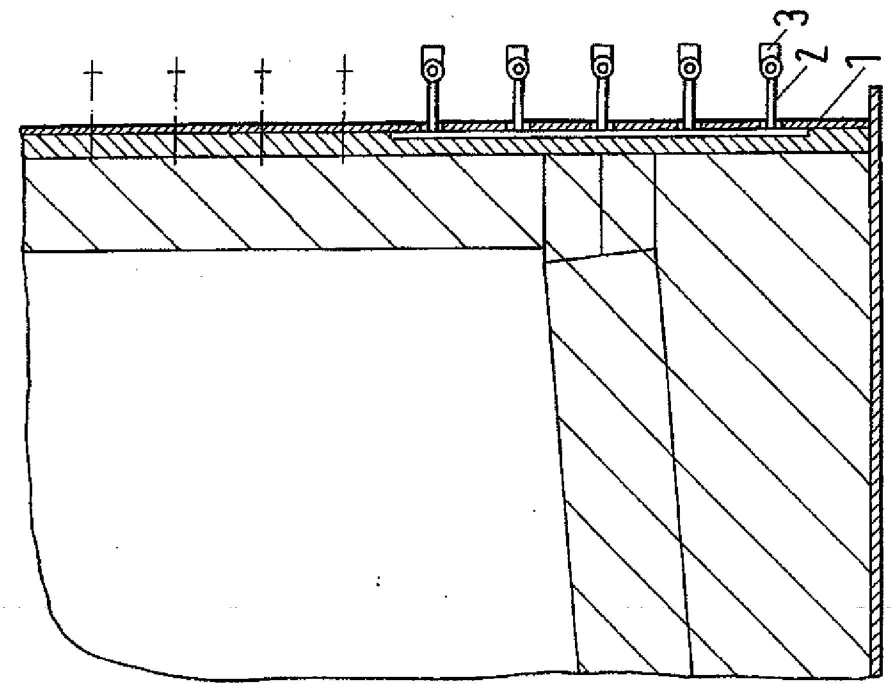


Fig.3

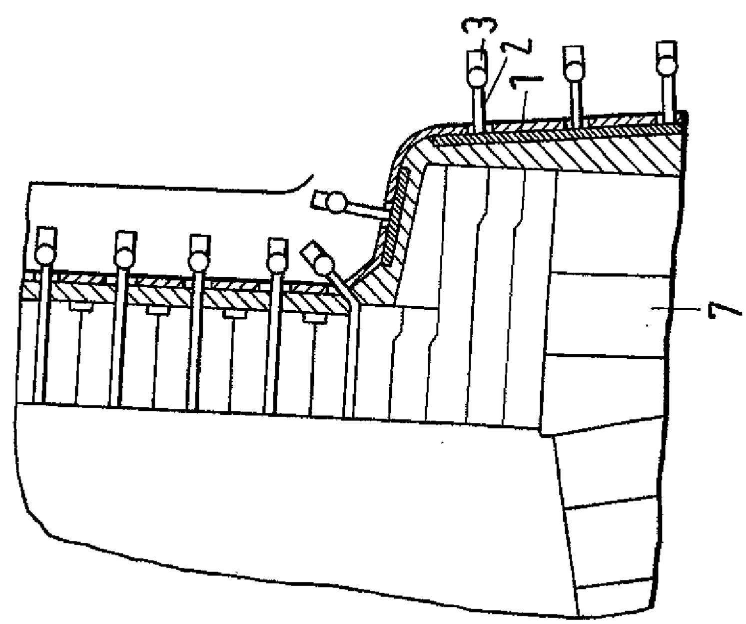


Fig.4

COOLING ELEMENT FOR COOLING THE FIREPROOF LINING OF A METALLURGICAL FURNACE (AC,DC)

PRIORITY CLAIM

[0001] This is a U.S. national stage of application No. PCT/EP20091000078, filed on Jan. 21, 2009, which claims Priority to the German Application No.: 10 2008 008 477.8, filed: Feb. 8, 2008, the contents of both being incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention is directed to a cooling element for cooling the refractory lining of a metallurgical furnace.

[0004] 2. Related Art

[0005] EP 887 428 A1 and DE 10 2004 035 968 A1 disclose cooling elements comprising a plate made of copper or a copper alloy that faces the refractory lining of a metallurgical furnace, such as a blast furnace, and which is provided in its interior with channels for guiding coolant.

[0006] Cooling elements of the type mentioned above have the disadvantage that the coolant, generally water, flows through the parts facing the interior of the furnace and, in the event of malfunctions or leakage, water can enter the interior of the furnace. This entails considerable risk.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a cooling element which has no such potential risk while providing a comparably good cooling action.

[0008] According to one embodiment of the invention a cooling plate that faces the refractory lining and, a heat-conducting plate, which is arranged at an angle to the refractory lining, is fixedly connected to the cooling plate and extends out of the furnace wall, the cooling plate and the heat-conducting plate are made of solid material, and a coolant channel is fixedly connected to the heat-conducting plate and which is connected to a coolant input and a coolant output.

[0009] The cooling plate, the heat-conducting plate and the coolant channel are made of highly heat-conductive material, e.g., copper or a copper alloy, and the coolant channel advantageously extends along a narrow side of the heat-conducting plate.

[0010] Because of the high heat conductivity of the cooling element, so much heat is drawn from the area between the refractory lining and the steel plating of the furnace vessel that the furnace vessel need no longer be cooled from the outside by spray water or duct cooling i.e., a dry furnace vessel. The cooling element can comprise one or more of rolled, forged, and cast copper plates with a fine-grained structure for good heat conductivity.

[0011] According to one embodiment of the invention, two solid copper plates of this kind can be welded together (connected in a thermally conductive manner) or bent to form a T-profile or L-profile. The end of the welded-on copper plate is also welded to a copper pipe serving as a coolant channel. This copper pipe is cooled by cooling water and, by way of the connected cooling plates, provides sufficient cooling of the brick lining of the furnace vessel located in the installation area.

[0012] The dimensions, quantity per unit of area, cooling circuit and the distances between the heat-conducting plates projecting out of the furnace vessel are calculated and determined in accordance with the required heat removal. The cooling elements are outfitted with corresponding measuring instruments for monitoring the temperature/heat removal curve.

[0013] The cooling elements can be installed at any position of the furnace vessel such as roof, side wall, or base, either horizontally or vertically between the brick lining and the steel wall of the vessel or roof or base. These cooling devices are preferably arranged in the lower and/or middle area of the vessel side wall typically referred to as a metal/slag liquid area and abutment, skewback area or, in case of DC furnaces, also in the gas area, between the refractory lining and the steel plating of the furnace vessel. The arrangement of the cooling elements in the abutment area of the brick lining does not impair the reinforcement of the furnace vessel arranged at that location. The cooling elements can be connected to the furnace vessel by screws or the like. A heat-conducting contact mass is tamped between the cooling elements and the brick lining.

[0014] The cooling elements admit cooling water through the copper pipes welded on the outside. The water-cooled parts of the cooling elements are arranged outside the furnace vessel. Therefore, in case of leaks, no water can enter the furnace and endanger furnace operation. A plurality of cooling elements are connected together in series to form a cooling circuit. However, the individual positioning is selected in such a way that in the event of failure of a cooling circuit the areas located next to it continue to be cooled indirectly. The cooling elements should preferably be connected to closed cooling circuits.

[0015] However, if there are half-closed or open cooling systems as a result of conversions, the cooling elements can also be connected to them if the quality of the cooling water and the floating contents are within the specified tolerances (quality).

[0016] The advantages which can be achieved by the cooling elements according to the invention can be summarized as follows: improvement by achieving a perfectly dry furnace vessel; improved heat removal compared to spray cooling and cascade cooling; and is usable in areas where the static requirements for the furnace vessel must be maintained.

[0017] Compared to other systems, only small openings in the furnace vessel are needed, which has a positive influence on the stability and coherence of the upper and lower vessel. The amount of heat carried off by the cooling elements is sufficient to prevent damage to the affected structural component parts and to cool down the inner side facing the process in such a way that solidified, cooled or non-reactive product forms a self-protection.

[0018] Further advantages result when an externally dry furnace vessel is to be achieved, especially when contamination (sulfur and/or dust) is extremely heavy and when corrosion of the furnace vessel wall and cooling water outage render the furnace operation problematic due to blockage of the pumps. The cooling elements are not in direct contact with the process or with the product either slag or metal, and can easily be combined with other copper cooling systems that are not located in the statically important areas of the furnace vessel. These cooling elements are particularly suitable for hard-to-reach locations at the furnace vessel, especially also in the bottom of a rectangular vessel, where an open spray cooling was formerly resorted to out of necessity. They can be used in AC/DC reduction furnaces with a rectangular furnace vessel and round furnace vessel. In the latter case, they are especially advantageous because the statics and/or stability of the furnace vessel are not impaired by the type, shape or installation position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiment examples for the cooling element according to the invention are described in the following with reference to the drawings.

[0020] In the drawings:

[0021] FIG. **1** is a perspective view of the cooling element;

[0022] FIG. **2** is the arrangement of the cooling element in a furnace wall;

[0023] FIG. **3** is the arrangement in a round furnace vessel; and

[0024] FIG. **4** is the arrangement in a rectangular furnace vessel combined with other systems.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] In FIG. **1**, the cooling element comprises a cooling plate **1**, a heat-conducting plate **2** and a coolant channel **3** connected thereto. Coolant Channel **3** has a coolant input **4** and a coolant output **5**. In order to achieve the best possible thermal conductivity, these parts are all made of copper or an appropriate copper alloy.

[0026] FIG. **2** shows that the cooling plate **1** is located directly between the outer casing of a metallurgical vessel **6** and the refractory lining **7** facing the interior of the furnace. It is preferably embedded in a heat-conducting contact mass **8** formed by tamping.

[0027] The arrangement of the cooling plates **1** and the heat-conducting plates **2** and coolant channel **3** are shown installed, by way of example, in a round furnace vessel in FIG. **3** and in a rectangular furnace vessel in FIG. **4**, other cooling element systems also being indicated in the drawing.

[0028] The drawings clearly show that the coolant channels are located outside the furnace vessel resulting in a dry furnace vessel.

[0029] Thus, while there have shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

1.-**7**. (canceled)

8. A cooling element for a refractory lining of a metallurgical furnace, comprising:

a cooling plate that faces the refractory lining;

a heat-conducting plate welded to the cooling plate in a heat-conducting manner and extending from the cooling plate at an angle to form a T-profile or L-profile that extends out of a furnace wall; and

a coolant channel fixedly connected to the heat-conducting plate projecting out of a furnace wall and is connected to a coolant input and a coolant output,

wherein the cooling plate and the heat-conducting plate are made of solid material.

9. The cooling element according to claim **8**, wherein the cooling plate, the heat-conducting plate and the coolant channel are made of highly heat-conductive material.

10. The cooling element according to claim **8**, wherein the coolant channel extends along a side of the heat-conducting plate opposite the cooling plate.

11. The cooling element according to claim **8**, wherein at least one of the heat conducting plate and the cooling plate comprises a highly heat-conductive material having a fine-grained structure that is one of rolled, forged, and cast.

12. The cooling element according to claim **8**, further comprising

a metallurgical vessel having an outer casing and the refractory lining facing the interior of the vessel, wherein the cooling element is embedded in a heat-conductive contact mass arranged between the lining and the outer casing.

13. The cooling element according to claim **12**, wherein the metallurgical vessel is one of round, angular, and oval.

14. The cooling element according to claim **10**, wherein the highly heat-conductive material is at least one of copper and a copper alloy.

15. Cooling element according to claim **10**, wherein the heat-conducting plate is substantially rectangular and the coolant channel extends along a narrow side of the heat-conducting plate.

16. The cooling element according to claim **12**, wherein the heat conducting plate and the cooling plate are copper plates.

17. A cooling element for cooling a refractory lining of a metallurgical furnace, comprising:

a cooling plate that faces the refractory lining, the cooling plate bent to form a heat-conducting plate extending from the cooling plate at an angle to form a T-profile or L-profile that extends out of a furnace wall; and

a coolant channel fixedly connected to the heat-conducting plate projecting out of a furnace wall and is connected to a coolant input and a coolant output,

wherein the cooling plate and the heat-conducting plate are made of solid material.

18. The cooling element according to claim **17**, wherein the cooling plate, the heat-conducting plate and the coolant channel are made of highly heat-conductive material.

19. The cooling element according to claim **17**, wherein the coolant channel extends along a side of the heat-conducting plate opposite the cooling plate.

20. The cooling element according to claim **17**, wherein at least one of the heat conducting plate and the cooling plate comprises a highly heat-conductive material having a fine-grained structure that is one of rolled, forged, and cast.

21. The cooling element according to claim **17**, further comprising

a metallurgical vessel having an outer casing and the refractory lining facing the interior of the vessel, wherein the cooling element is embedded in a heat-conductive contact mass arranged between the lining and the outer casing.

22. The cooling element according to claim **21**, wherein the metallurgical vessel is one of round, angular, and oval.

23. The cooling element according to claim **19**, wherein the highly heat-conductive material is at least one of copper and a copper alloy.

24. Cooling element according to claim **19**, wherein the heat-conducting plate is substantially rectangular and the coolant channel extends along a narrow side of the heat-conducting plate.

25. The cooling element according to claim **21**, wherein the heat conducting plate and the cooling plate are copper plates.

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