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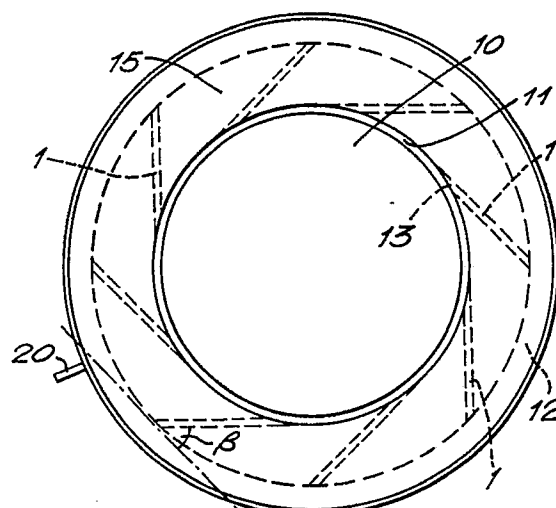
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DE FR GB IT SE(71) Applicant: **FOSECO INTERNATIONAL LIMITED**
285 Long Acre
Nechells Birmingham B7 5JR(GB)(72) Inventor: **Comes, Heinrich**
Boomkamp 20
W-3-Weseke(DE)
Inventor: **Wolf, Josef**
Zillestrasse 6
W-4130 Moers(DE)(74) Representative: **Moore, John Hamilton**
Fosco Holding International Limited Group
Patents Department 285 Long Acre Nechells
Birmingham B7 5JR(GB)(54) **Method and apparatus for closing the gap between an electrode and its furnace cover in an electric furnace.**

(57) The invention relates to a method for closing the gap between a graphite electrode and a through-hole for the electrode formed in the furnace cover of an electric furnace by means of a cooling sealing ring made of a refractory material.

To the gap there is fed a gas-fluid-mixture via a plurality of conduits in the cooling sealing ring uniformly distributed over its circumference, radially inside and aligned in tangential-radial direction with a small axial component which gas-fluid-mixture serves to seal, the fluid of which additionally also withdraws heat from the inside region of the cooling sealing ring by endothermic actions, by vaporisation and/or by cracking to graphite or petrol coke at the surface of the electrode.

**FIG.1.****EP 0 437 037 A2**

METHOD AND APPARATUS FOR CLOSING THE GAP BETWEEN AN ELECTRODE AND ITS FURNACE COVER IN AN ELECTRIC FURNACE

The invention relates to a method for closing the gap between a graphite electrode and a through-hole for the electrode formed in the furnace cover of an electric furnace by means of a cooling packing ring made of refractory material and relates also to an apparatus for performing this method.

When preparing steel according to the arc furnace process, electric energy is transferred by graphite electrodes to the material to be melted. The top of the accompanying furnace vessel is closed by a cover, which is provided with openings for the passing of the electrodes, which openings, for reasons of operational safety, are larger than the electrodes. Through these gaps, however, hot gas escapes in the course of the fusion process, which contaminates and damages the upper structure of the furnace and furthermore, this loads the furnace hall with dust. Moreover, local heating of the graphite electrodes occurs, inducing additional loss by non-uniform burning off.

In order to minimise this loss which has nothing to do with the actual fusion process, so-called coated electrodes have been used, in which the graphite on the surface is protected by a coat of aluminium compositions and boric acid respectively, containing refractory components. These coating methods, however, are too uneconomical today.

It is also known to spray water onto the graphite surfaces above the passage through the cover into the interior of the electric furnace. With this a certain cooling effect can be achieved, which, on the one hand originates from the temperature rise of the water and partly from the evaporation heat of the water. However, this cooling effect takes place above the passage or the sealing place, respectively, without a specific effect occurring with regard to cooling or sealing on the sealing region.

In a known apparatus of the initially mentioned kind (European Patent Publication No. 0080335) gas is inserted in substantially tangential direction into a ring- and spiral-shaped chamber which is open towards the electrode. However, the cooling effect achieved with this is - just like the sealing effect of the known apparatus - varying in strength over the circumference, with the result of a locally insufficient sealing and larger burning off of the electrodes.

In a further known apparatus of the initially mentioned kind, (U.S. Patent No. 3697660) two half rings are provided which surround the electrode in spaced relation. Each of said half rings is provided at its radial inside with a plurality of uniformly distributed openings, through which inert gas es-

capas which was introduced into the half ring. At both sides of the outlet openings there are blades running in radial-tangential direction in order to produce a gas flow around the surface of the electrode. With this an equalisation of both the cooling effect and the sealing effect can be achieved, due to the oncoming flow of gases. However, no optimal cooling and sealing effect can be achieved.

The invention is based on the problem to develop a method and an apparatus of the initially mentioned kind in a manner that on the one hand there is achieved a sealing effect uniformly distributed over the circumference, but on the other hand there is also possible an optimal cooling of the surface of the electrode.

Accordingly, in a first aspect the invention provides a method of sealing the gap between a graphite electrode and a through hole for the electrode formed in the cover on an electric furnace using a cooling sealing ring of refractory material, in which a gas-fluid mixture is fed to the gap via a plurality of conduits in the cooling sealing ring, the conduits being uniformly distributed around the circumference of the sealing ring and extending in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode, whereby the gas-fluid mixture acts as a seal and the fluid absorbs heat from the region inside the cooling sealing ring by endothermic reaction, vaporisation and/or cracking to form graphite or petroleum coke.

The axial inclination of the conduits is preferably towards the tip of the electrode.

In a second aspect the invention provides an apparatus for sealing the gap between a graphite electrode and a through hole for the electrode formed in the cover of an electric furnace which comprises a cooling sealing ring of refractory material, the cooling sealing ring having a plurality of conduits uniformly distributed around its circumference and opening into the gap, the conduits extending through the sealing cooling ring in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode.

The angle of axial inclination of the conduits is preferably up to 30° , especially 5° to 20° . The angle of the conduits from the tangential at the exterior circumference of the sealing ring is preferably from 10° to 170° .

Thus, an essential feature of the invention is the mixed tangential-radial-axial oncoming flow of the gases onto the surface of the electrode, the

vector of the gas-fluid-mixture flowing onto the surface having components not equal to zero in all three cylinder co-ordinates. By this means it is at first achieved that the cooling gases reach the hot surface, cool this by self-heating and the heated gases seal the gap, thus inhibiting the escape of furnace gases.

In the present invention, however, there still exists another effect of particular importance, particularly an endothermic effect. By using a gas-liquid-mixture of a certain composition, it can be achieved that this mixture or the fluid component vaporises in the area of the sealing means. For this vaporisation step a specific energy is necessary which is taken from the environment, which means that in the sealing area the electrode is cooled down to an extraordinary extent. Due to the transition of the fluid component of the mixture into the gas form there also occurs an increased sealing effect, so that in the sealing region one could speak of a kind of sealing ring of gaseous material. These two effects only occur with the apparatus according to the invention, so that in this context a cooling sealing ring may correctly be referred to, whereas in the state of the art there merely existed sealing rings with a certain cooling.

It is also within the scope of the present invention to select a very specific composition of the gas-fluid-mixture. When using e.g. an oil, this oil will reach the graphite surface of the electrode via the flow of the gas. Due to the existing temperatures the oil cracks and the energy required for this step is again withdrawn from the environment of the sealing area, which leads to an additional cooling effect. As a result of this cracking step a coating of graphite or petroleum coke is provided at the surface of the graphite electrode and this coating furthermore forms a protection of the electrode and aids a uniform consumption of the electrode in the circumferential direction.

In the sense of the present invention a gas-fluid-mixture is to be understood to be a composition of individual gases and liquids but may also include powder particles, but also mixtures (also in form of emulsions or dispersion), which causes the effect of temperature reduction by changing the aggregate state (vaporisation, cracking, other changes in state) as well as a coating of the surface of the electrode and a reduction of the width of the gap.

In the following the invention is explained by way of example with reference to the drawing.

Figure 1 shows a top view of an apparatus according to the invention with the individual feed conduits for the gas-fluid-mixture.

Figure 2 shows a cross-sectional view through one of the feed conduits.

In Figure 1, electrode 10 has a gap 11 sur-

rounding the electrode, the gap being defined between the electrode and a concentric cooling sealing ring 15. In the cooling sealing ring 15 there is provided a plurality (in the drawing there are shown eight thereof) of oblique bores 1 (shown at tangential angle β) each of which opens into gap 11 via an opening 13 and which serve as feed conduits. Conduit 1 is supplied by a ring conduit 12 which is either positioned in the cooling sealing ring 15 or on the outside of this cooling sealing ring and which in turn is supplied with a gas-fluid-mixture via a feed connection 20.

From Figure 2 there is evident the slight axial inclination (angle α) of the individual conduits 1. Openings 13 may be of part-circular, axial or angular, e.g. wedge-shaped form.

Gases, e.g. air, steam, natural gas, coke oven or water gas, nitrogen, carbon monoxide and carbon dioxide or the like, with fluid media, e.g. water, oils, fats, tars, highly volatile coals (lignites, open-burning or gas flame coals), alcohol or the like, may be supplied through the conduits. In a preferred embodiment those fluids are used which are composed such that they withdraw from this region additional heat by vaporisation when entering the gap or when touching the electrode surface, so that an increased cooling effect occurs.

The outside of the cooling sealing ring may be provided with a type of sheet cover, which may be cylindrical as well as profiled, wherein e.g. a concave opening of the profile can simultaneously serve as a central supply channel.

Claims

1. A method of sealing the gap between a graphite electrode and a through-hole for said electrode formed in the furnace cover of an electric furnace using a cooling sealing ring made of refractory material, characterised in that a gas-fluid-mixture is fed to the gap (11) via a plurality of conduits (1) in the cooling sealing ring (15) the conduits (1) being uniformly distributed around the circumference of the sealing ring (15) and extending in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode (10), whereby the gas-fluid-mixture acts as a seal and the fluid absorbs heat from the region inside the cooling sealing ring (15) by endothermic actions, by vaporisation and/or by cracking.
2. A method according to Claim 1, characterised in that the fluid is an oil, fat, tar, water or alcohol.
3. A method according to Claim 1 or 2, charac-

terised in that the gas is air, steam, natural gas, coke oven or water gas, nitrogen, carbon monoxide or carbon dioxide.

4. A method according to Claim 1, 2, or 3, characterised in that the gas-fluid-mixture additionally contains powder particles. 5

5. A method according to Claim 4, characterised in that the powder particles are volatile coals, e.g. lignite or open-burning coals. 10

6. An apparatus for sealing the gap between a graphite electrode and a through-hole for the electrode formed in the cover of an electric furnace which comprises a cooling sealing ring made of refractory material, characterised in that in the cooling sealing ring (15) has a plurality of conduits or channels (1) which are uniformly distributed around its circumference and opening into the gap (12), which conduits or channels (1) extend through the sealing cooling ring (15) in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode (10). 15
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7. An apparatus according to Claim 6, characterised in that the angle of axial inclination of the conduits (1) is from 1° to 30°. 30

8. An apparatus according to Claim 7, characterised in that the angle of axial inclination of conduits (1) is from 5° to 20°. 35

9. An apparatus according to Claim 6, 7 or 8, characterised in that the axial inclination of the conduits (1) is towards the tip to the electrode (10). 40

10. An apparatus according to Claim 6, 7, 8, or 9, characterised in that the angle of the conduits (1) from the tangential at the exterior circumference of the sealing ring (15) is from 10° to 170°. 45

11. An apparatus according to any one of Claims 6 to 10, characterised in that the conduits (1) are connected to a ring conduit (12) which is inside or on the outside periphery of cooling sealing ring (15). 50

12. An apparatus according to any one of Claims 6 to 11, characterised in that the conduits feed into the gap (11) via openings (13) of particular circular or oval or angular form. 55

