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(71) Applicant
ASEA Aktiebolag,
(Sweden),
Vasteras,
Sweden
(72) Inventors
Ake Archenholtz,
Ulf Homberg
(74) Agent and/or address for service
J. Y. and G. W. Johnson,
Furnival House,
14—18 High Holborn,
London,
WC1V 6DE

(54) Improvements in brick-formed basic refractory linings for metallurgical furnaces

(57) A method for lining a metallurgical furnace, such as a crucible furnace, and especially a large furnace, with bricks of a basic lining material in which inter-brick sintering is prevented by applying a sintering-preventing coating at least to the surfaces of each brick which are destined to contact an adjacent brick. The bricks in the layer (2) can be of arcuate form and forced into contact one with another by a layer (3) rammed between the layer (2) and an electrical coil (4). The coating may be magnesium chromite.

FIG. 1

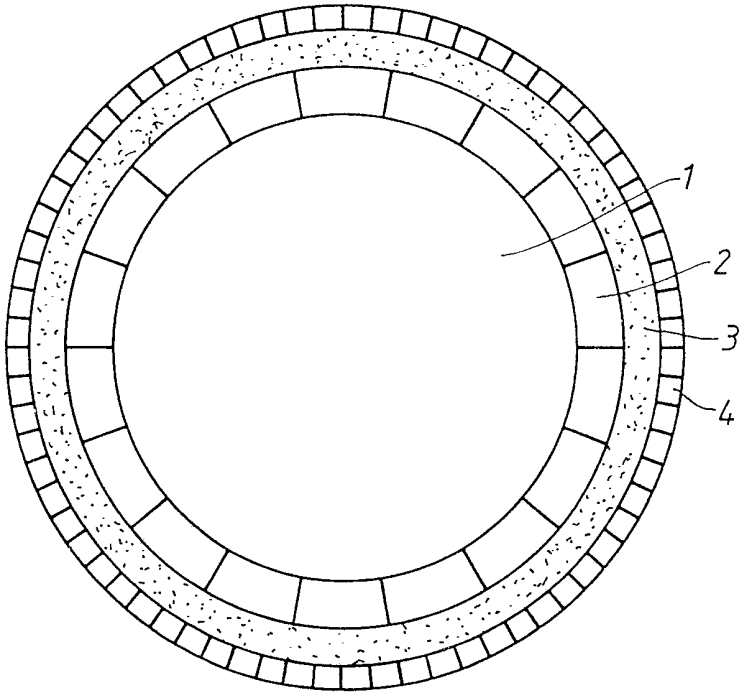

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FIG. 1

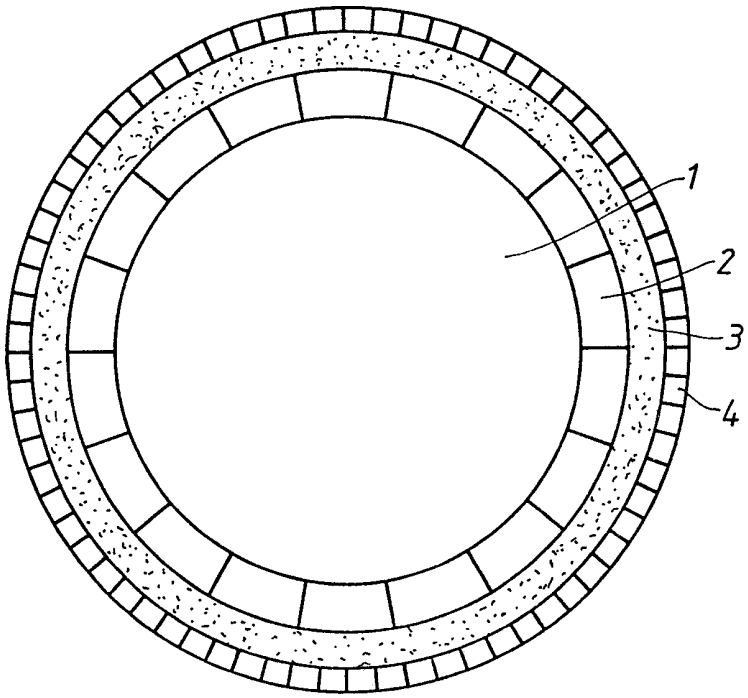
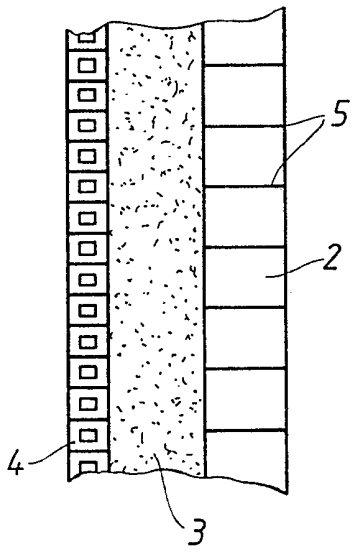


FIG. 2



SPECIFICATION

Improvements in and relating to brick-formed basic refractory linings for metallurgical furnaces

This invention relates to a method of lining a metallurgical furnace, such as a large crucible furnace, with basic refractory lining bricks and to a furnace so lined.

When using a basic refractory lining in a crucible furnace or other metallurgical furnace, the lining material will often acquire a small number of large cracks. These cracks occur upon changes in temperature and are due to unfavourable dilatation properties of the lining material. Usually the lining material is in the form of bricks, adjacent bricks being joined to each other with a cement so that a relatively strong joint is created between the individual bricks. Even if the bricks are applied in a dry state without using a cement, the separate bricks sinter together in use, again creating interbrick joints which are sufficiently strong for the lining to crack under thermal stress, so that even in this case a small number of large cracks can form in the lining. These cracks are frequently wide enough to allow metallic melt to flow into them. The cracks which form often extend right across the bricks at locations remote from the joints. Some cracking of the lining is to be expected, in use of the furnace, and the present invention relates to a method of controling the cracking so that the resultant cracks will be so narrow that metallic melt is not able to penetrate through the cracks or, to any substantial amount, into the cracks.

According to one aspect of the present invention, there is provided a method of lining a metallurgical furnace with refractory bricks of a basic lining material, which comprises providing at least those surfaces of each brick which confront another brick in the lining with a sintering-preventing coating, and placing the bricks one against another with the coatings of adjacent bricks in contact.

Conveniently, the bricks are arranged in endless layers one upon another, the bricks tapering towards the centre of each layer and being forced towards the centre to pack the bricks in each layer tightly one against another.

The sintering-preventing coating may comprise magnesium chromite.

By avoiding the use of a binding agent, such as cement, to secure adjoining bricks together in the lining, and ensuring the bricks do not sinter together, the cracks which appear will follow the joints between bricks and are so narrow as to prevent melt from penetrating into or through them.

According to a further aspect of the invention, there is provided a metallurgical furnace comprising a melting hearth defined within a refractory basic lining, the lining being formed from a plurality of bricks disposed one in contact with another without the intermediary of a binding agent between adjacent bricks, each brick at least on those surfaces which contact an adjacent brick being provided with a sintering-preventing coating.

The following arithmetical example may illustrate the invention:

A furnace with a diameter of 2 m is lined with basic bricks with a reversible thermal linear expansion of 0.6% between 1,200 and 1,600°C.

a) In the case of a prior art lining, it can be assumed that six cracks will arise around the circumference.

The width of each crack is then

$$\frac{\pi \times 2{,}000 \times 0.6}{6 \times 100} = 6.3\text{mm}.$$

It will be seen therefore that cracks of a considerable width will appear, through or into which a metallic melt may easily penetrate.

b) If the lining consists of arcuate bricks with an arcuate length of 75 mm, and it is assumed no interbrick sinter occurs at the joints, since there are

$$\frac{\pi \times 2{,}000}{75}$$

joints per circular layer and thus the width of the crack which occurs at each joint is

$$\frac{\pi \times 2{,}000 \times 0.6 \times 75}{100 \times \pi \times 2{,}000} = 0.45\text{ mm}.$$

These cracks are too narrow to permit any substantial melt penetration.

Thus, by ensuring that the cracks which form follow the joints between the bricks, each crack will be so narrow that there will be little or no melt penetration into the cracks. The sintering-preventing layer employed in the method of the invention prevents adjacent bricks from sintering together and thus avoids the formation of cracks in the bricks. One example of a material for the sintering-preventing layer is that claimed in the specification of our British Patent Specification 1,057,388. In this specification a sintering-preventing compound is described, which comprises at least 85 *per cent* by weight of magnesium oxide and chromic oxide, of which at least 90 *per cent* by weight is combined as magnesium chromite $MgO \times Cr_2O_3$. The compound may contain at the most 6 *per cent* by weight of magnesium oxide, MgO, and/or 6 *per cent* by weight of chromic oxide, Cr_2O_3, in free form. The thickness of the sintering-preventing coating may be from a very small thickness up to, for example, 5 mm.

The invention will now be further described, by

way of example, with reference to the accompanying drawing, in which:—

Figure 1 is a horizontal cross-section through a crucible furnace lined in accordance with the method of the invention, and

Figure 2 is a partial vertical section through the furnace of Figure 1.

Figure 1 shows, in section, a large crucible furnace with a melting hearth 1 which is surrounded by a refractory lining 2 of arcuate bricks coated with a sintering-preventing material at least over those surfaces thereof which confront adjacent surfaces of other bricks. Outside of this brick-formed lining 2 there is applied a layer 3 of a powdered material which has been rammed between the brick lining 2 and a surrounding electrical coil 4. Figure 2 shows a vertical section through the furnace wall showing the brick lining 2, the layer 3 of rammed compound and the coil 4, and shows the horizontal interfaces between layers of the bricks. The coatings of sintering-preventing material are shown at 5 in Figure 2.

As will be seen from Figure 1, the confronting surfaces between bricks in each horizontal layer are directed towards the vertical axis of the furance. When the layer 3 is rammed, an inwardly-directed pressure is generated on the bricks, urging them towards the axis, and the bricks naturally are pressed one against another to form a stable lining layer. Sintering of the bricks together will be substantially prevented by the coatings 5, possibly with the exception of the radially-innermost portions located nearest the melt, and the cracks which arise in use of the furnace will be very narrow and will follow the lines of the joints between the bricks. Penetration of melt into or through the cracks will thus be substantially prevented.

The lining of the furnace illustrated would typically be carried out as follows:

The bricks forming the lining 2 are each provided with sintering-preventing coatings 5 on those surfaces which will confront other bricks in the lining and are laid, as is clear from Figure 1, inside the coil 4 to define the melting hearth. Refractory compound 3 is then rammed between the bricks and the coil 4, thus causing the bricks to be tightly packed together with the creation of a stable lining layer. In use of the furnace, the cracks which do appear are all located at the joints between bricks and are all too narrow to permit any substantial melt intrusion thereinto. When lining the furnace, no joining cement or similar binding agent is used between bricks, the bricks, being laid loosely one on top of another and side by side in each horizontal layer.

Claims

1. A method of lining a metallurgical furnace with refractory bricks of a basic lining material which comprises providing at least those surfaces of each brick which confront another brick in the lining with a sintering-preventing coating, and placing the bricks one against another with the coatings of adjacent bricks in contact.

2. A method as claimed in claim 1, in which the bricks are arranged in endless layers one upon another, the bricks tapering towards the centre of each layer and being forced towards the centre to pack the bricks in each layer tightly one against another.

3. A method as claimed in claim 2, in which a layer of a powdered compound is arranged between a furnace coil and the endless layers of bricks forming the lining, said compound being rammed to pack the bricks one against another.

4. A method as claimed in any preceding claim, in which the sintering-preventing coating comprises magnesium chromite.

5. A method as claimed in any preceding claim, in which the thickness of the sintering-preventing coating on each brick does not exceed 5 mm.

6. A method of lining a metallurgical furnace substantially as hereinbefore described with reference to the accompanying drawing.

7. A metallurgical furnace comprising a melting hearth defined within a refractory basic lining, the lining being formed from a plurality of bricks disposed one in contact with another without the intermediary of a binding agent between adjacent bricks, each brick at least on those surfaces which contact an adjacent brick being provided with a sintering-preventing coating.

8. A furnace as claimed in claim 7, in which the melting hearth is of circular cross section, the bricks being of arcuate form and arranged in endless layers one on another, each endless layer of bricks being forced towards the centre of the melting hearth whereby the bricks in each layer are packed tightly one against another.

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