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(54) **A METHOD FOR REPAIRING A REFRACTORY WALL OF A FURNACE**

(57) The present invention relates to a method for repairing a refractory wall (2) of a furnace (1) by replacing at least a wall portion (3) thereof, the method comprising:
(a) demolishing the wall portion (3);
(b) installing an outer form (4) defining a new wall portion (3) in situ, and an inner form (5) defining a new flue passage within the new wall portion (3);
(c) adding a refractory castable material within a volume defined by the outer form (4) and the inner form (5) and allowing the material to cure;
(d) removing the outer form;
characterized in that the inner form (5) is made from a heat resistant metallic material.

The present invention also concerns a wall portion for a furnace and a furnace.

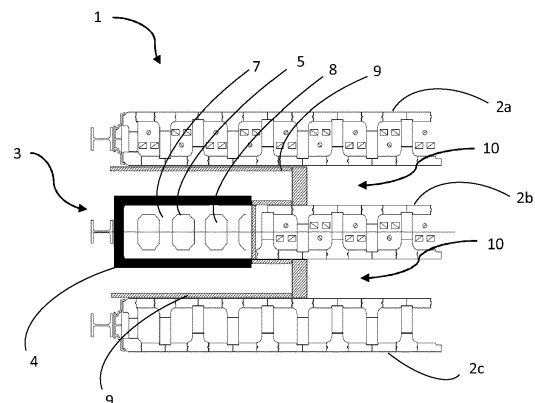


Fig. 3

Description

TECHNICAL FIELD

[0001] The present invention concerns a method for repairing a refractory wall of a furnace. The present invention also concerns a wall portion for a furnace and a furnace.

BACKGROUND OF THE INVENTION

[0002] Furnaces are well known for heating materials for different purposes. Furnaces may be constructed in various ways, but typically comprise elements such as a floor (or corbel), a roof and walls reaching therebetween, thereby forming a heating chamber for the material to be heated in. The floor, roof or walls may have channels for transporting hot gas, often referred to as flue passages, thereby heating the chamber.

[0003] Each element is typically built up from ceramic bricks, the bricks being assembled to define vertically and/or horizontally extending internal flues, vents and other passages within the elements, such as the heating walls.

[0004] Due to the harsh thermal cycling environment and operating practices of a furnace, some or all of the elements of the furnace may require repair and/or reconstruction during the furnace lifetime.

[0005] It is known to repair sections of the furnace by casting a refractory material between a form defining the part towards the chamber and an inner form defining the flue passage. The form towards the chamber can then be easily removed, but the inner form is more complex to remove. One method of doing so is to install wooden inner forms that will later be removed by burning away the wood when heating the oven to its operating temperature. A problem with using wood is that it takes time to make the forms, especially if complex forms for defining the flue passages are needed. Further, wood is not very form stable, i.e. will compress when put under pressure of the casting materials, thereby complicating the design process of the form. As such, in the case of repairing vertical wall portions of the furnace, the wall portion is often divided into sections, so that the next section is formed on top of the other after it has cured, thereby making the repair rather time consuming.

[0006] Another method is to use an inner form made from iron (Fe). The iron will corrode when exposed to oxidizing gases and heat from the furnace, causing it to flake and melt. When the iron melts it will negatively affect the melting point of the surrounding refractory ceramic material as well. The iron form must therefore be removed before operating the furnace. As such, the removal is an expensive process and limits the complexity of the shape of the flue passage that can be formed. Further, again in the case of repairing vertical wall portions of the furnace, also here the wall portion is often divided into sections so that the iron form can be removed by machining.

SUMMARY OF THE INVENTION

[0007] In view of the above, a first object of the invention is to provide an improved method for repairing a refractory wall of a furnace which to at least to some extent overcomes some of the issues of the prior art. A further object of the invention is to provide an improved wall portion for a furnace. A yet further object is to provide an improved furnace.

[0008] According to a first aspect of the invention, the first object is achieved by a method comprising the steps recited in claim 1. Thus, a method of repairing a refractory wall of a furnace by replacing at least a wall portion thereof is provided. The method comprises:

- (a) demolishing the wall portion;
- (b) installing an outer form defining a new wall portion in situ, and an inner form defining a new flue passage within the new wall portion;
- (c) adding a refractory castable material within a volume defined by the outer form and the inner form and allowing the material to cure;
- (d) removing the outer form; where the inner form is made from a heat resistant metallic material.

[0009] By the provision of the method as disclosed herein, an improved method for repairing a refractory wall of a furnace is provided, in which the inner form inner form defining a new flue passage is made from a heat resistant metallic material. In particular, it has been realized that by providing an inner form of heat resistant metallic material, the inner form can be left inside the wall portion, without the need to remove it before operating the furnace, thereby simplifying and making the repair process more cost efficient.

[0010] Furthermore, by making the inner form from a metallic material, a gas tight flue passage can be formed. The metallic material also provides an increased flexibility to the repairing method, as more complex shapes can be made, easily customizable by means of conventional metal working to fit the context of an individual furnace to be repaired.

[0011] For purposes of this invention, it will be assumed that a portion of a wall needs to be repaired, but it will be appreciated that the repair process described herein is applicable to situations where entire walls, the roof and/or the floor/corbel areas, or portions thereof, need replacement. Accordingly, reference to a "wall portion" is intended to encompass both vertical walls as well as horizontal roof and floor/corbel portions.

[0012] By furnace is meant any furnace, such as a furnace for making coke or glass or otherwise heating a material inside for different purposes. Other terms for "furnace" may be "oven" or "kiln". Furnace is used henceforth to describe the context of the wall to be repaired, but it could also be applicable to other forms of heating apparatus, such as boilers, smelters/blow-furnaces, stoves or fireplaces to give a few non-limiting examples.

[0013] Furnaces often comprise a chamber to heat material that may often be defined by walls, a floor and a ceiling for the furnace. Some furnaces have a plurality of chambers that are each separated by a wall in between. Some types of furnaces often have several chambers. A typical coke oven installation might include, for example 30 to more than 100 individual coking chambers or ovens arranged side-by-side, with each chamber being from 3 to 7 meters high, typically 14 or more meters long, and approximately about 1 meter wide.

[0014] By installing an outer form defining a new wall portion "in situ" is meant "inside the existing furnace". It may also mean "at the existing furnace", for instance in the case of the wall being an outer wall facing the external side of the furnace.

[0015] Flue passage is a well-known term in the field of furnaces. Flue passages are channels in the walls of furnaces to transport gases for heating the order to heat the furnace. Flue passages may also be integrated into the floor and/or the ceiling of the furnace.

[0016] That the refractory castable material is added within a volume defined by the outer form and the inner form should be understood as a volume restricted substantially by the inner and outer forms. Naturally, also the remaining wall outside of the wall portion to be repaired will be defining the actual volume into which the refractory castable material is added.

[0017] By heat resistant metallic material is meant a metallic material that can be exposed to high temperatures whilst maintaining its material characteristics. By high temperatures is meant around 1000°C and above. Preferably, the heat resistant metallic material does not generate gases or affect the surrounding refractory castable material, even when heated to above 1000°C.

[0018] Optionally, the heat resistant metallic material is form stable when heated during operation of the furnace, such as to temperature between 1000°C and 1200°C. By form stable is meant that the material maintains its shape. During operation of some types of furnaces, such as coke furnaces, the temperature may go up 1200°C. For such elevated temperatures, many materials are likely to deform, thereby altering the shape of the flue passage. This may cause a number of problems, such as yielding a non-uniform heating of the wall, as well as lowering the heating capabilities of the furnace, as it may be an obstructed flow of gas through the flue passage. Thereby, by using a heat resistant metallic material that is form stable at this temperature, these problems may be avoided.

[0019] Still optionally, the heat resistant metallic material is form stable when heated even when to a temperature between 1200°C and 1400°C. It has namely been found that, albeit the normal temperature of a furnace may normally be 1000-1200°C, the flue passages may sometimes come up to temperatures of around 1300°C, such as during heating of the furnace to get it up to operating temperature. At this temperature, depending on the shape and the height of the flue passage, i.e. how

much weight the metallic material of the flue passage may put on itself in bends etc, heat resistant steel may further deform so that it slides down such that the flue passage become completely blocked. By having a heat resistant metallic material that is form stable at this temperature, this problem with deformed and even potentially blocked flue passages can be avoided. Still optionally, the heat resistant metallic material is form stable at a temperature between 1250°C and 1350°C.

[0020] Optionally, the heat resistant metallic material is chemically stable when heated to a temperature of operation of the furnace, such as to temperature between 1000°C and 1200°C, preferable even when heated to a temperature between 1200°C and 1400°C. By chemically stable is meant that the material it is not reactive in this environment and retains its useful properties. In particular, the usefulness is retained in the heat and corroding gases. In this meaning, the material is said to be chemically unstable if it for example would melt, corrode, decompose, or burn under the conditions provided in the flue passage. It has namely been found that material, despite being heat resistant and form stable, may react with a surrounding environment characterized by high temperature and corroding gases, causing the material to deteriorate, such as by corrosion. As such, the lifetime of the wall is reduced as the material itself deteriorates, but also as gases may emit from the material and adversely affect the refractory material of the furnace, such as by reducing its melting point. By use of a metallic material that is also chemically stable, these problems are reduced.

[0021] Optionally, the heat resistant metallic material forms a protective surface oxide layer when heated to a temperature of operation of the furnace, such as when heated to 1000°C. As such, the metal material can resist the problems with high temperatures and corrosion, as explained above, to an even higher degree.

[0022] Optionally, the metallic material is an aluminium containing alloy that forms a protective Al_2O_3 surface layer when heated to a temperature of operation of the furnace, such as when heated to 1000°C. Al_2O_3 , or aluminium oxide, commonly known as alumina, has a high melting point, high hardness, high compressive strength, low friction coefficient, and high resistance against corroding environments. As such, Al_2O_3 provides further performance to the material's chemical stability, thereby providing a more long-lasting flue passage with increased service life.

[0023] Optionally, the heat resistant metallic material is a ferritic iron-chromium-aluminium alloy (FeCrAl).

[0024] Preferably, the metallic material is a ferritic iron-chromium-aluminium alloy (FeCrAl) comprising, in percent by weight:

- 19-25% Cr, preferably 20-22% Cr
- 3-7% Al, preferably 4-6% Al
- optionally 1-5% Mo, preferably 2-4% Mo
- optionally maximum 0.1% C, preferably maximum

- 0.08% C
- optionally maximum 1% Si, preferably maximum 0.7% Si
- optionally maximum 0.5% Mn, preferably maximum 0.4% Mn
- balance Fe and unavoidable impurities.

[0025] Optionally, the new wall portion is formed in one piece by completion of steps a) to d). By using conventional methods, the new wall portions often need to be formed in a stepwise procedure by forming sections to be formed on top of the other. This may especially be the case if the wall portion has complex flue passage shape, or if the wall portion reaches tall in a vertical direction. This may further be the case when the wall portion is the entire vertical wall section. This is due to that the inner form needs to be removed, and/or that the shape of the inner forms deforms due to a high pressure from the added castable refractory material, yielding difficulties to make the entire wall portion in one go. It has been found that by using an inner form of a heat resistant metallic material that does not need to be removed before operation, the whole wall portion may be done in one step, even when the wall portion to be repaired is the entire wall.

[0026] Optionally, the refractory castable material is a silica- and/or alumina-based material. These materials are particularly good for resisting heat while also being affordable to use.

[0027] Optionally, the inner form has a telescopic construction. Thereby, a more flexible inner form is provided that can be easily adjusted to fit the conditions of the wall portion to be repaired. As no sections need to be formed, the time required for the repair process is significantly reduced, making the repair process more cost efficient and reducing the time that the furnace is out of operation.

[0028] Optionally, the refractory wall is a brick wall. The method is namely found particularly beneficial when repairing brick walls, as a lot of the complexity of repairing brick walls with fitting individual bricks and forming joints and seams in between the bricks and flue passages is made redundant.

[0029] The present invention also relates to a wall portion for a furnace. The wall portion comprises a main portion made from a refractory castable material, and an inner form in contact with the main portion. The inner form delimits a flue passage of the refractory wall portion and is made from a heat resistant metallic material. As such, a wall portion that does not need the inner form to be removed before installation or operation of a furnace is provided. Further, as such, the wall portion is substantially gas tight, preventing gas to leak out in cracks of the wall etc. Also, the wall portion may be pre-formed already before the repair process, simplifying and shortening the *in situ* repair process, i.e., the repair process inside the furnace as it is taken out of operation, yielding more up time for the furnace.

[0030] Accordingly, the present invention also relates

to a furnace comprising a wall portion according to the invention.

[0031] Optionally, the furnace is a coke furnace. It has namely been found that, due to the size and construction of coke furnaces, the method for repairing a wall portion may be particularly beneficial in this case. Typically, coke is produced in a coke furnace battery which includes a plurality of side-by-side coking chambers or ovens which are separated from each other by walls extending the full length of the chambers. The coke is pushed in the lengthwise direction out of the furnace. A typical coke furnace installation might include, for example 30 to more than 100 individual coking chambers or ovens arranged side-by-side, with each chamber being from 3 to 7 meters high, typically 14 or more meters long, and approximately 1 meter wide. Each wall is typically built up from a number of horizontally extending courses of ceramic bricks, the bricks being assembled to define vertically and/or horizontally extending internal flues, vents and other passages within the heating walls.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The present invention will hereinafter be further explained by means of non-limiting examples with reference to the appended schematic figures where;

Fig. 1 is a flowchart of a method according to an example embodiment of the present invention;

Fig. 2 is a schematic side view of a refractory wall according to an example embodiment of the present invention;

Fig. 3 is a schematic top view of a furnace according to an example embodiment of the present invention; and

Fig. 4 is a schematic cross-sectional top view of a wall portion according to an example embodiment of the present invention.

[0033] It should be noted that the drawings have not necessarily been drawn to scale and that the dimensions of certain features may have been exaggerated for the sake of clarity.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0034] Fig. 1 depicts a flowchart of a method according to an example embodiment of the present invention. The method is a method of repairing a refractory wall 2 of a furnace 1 by replacing a wall portion 3 thereof, such as the wall portion 3 as depicted in figs. 2-4.

[0035] The method comprises steps of:

(a) demolishing the wall portion 3. The demolishing

step may be accomplished by any suitable mechanical means.

(b) installing an outer form 4 defining a new wall portion 3 *in situ*, and an inner form 5 defining a new flue passage 8 within the new wall portion 3. The inner form 5 is made from a heat resistant metallic material.

(c) adding a refractory castable material within a volume defined by the outer form 4 and the inner form 5 and allowing the material to cure. The refractory castable material may be a silica- and/or alumina-based material, but it could also be any other refractory material suitable for casting. The adding of the refractory castable material typically comprises casting of the refractory castable material.

(d) removing the outer form 4. As the outer form 4 is removed, it can be made from any suitable material, such as wood, cardboard, fibreboard, plywood etc. It may also be made from a metallic material, or wood-metal laminates. The removal of the outer form 4 may be performed by mechanically removing the outer form 4 before the wall portion 3 is put in operation. It may also be removed by burning off the outer form 4, such as when heating the wall portion 3 when initiating operation of the furnace 1 after the repair.

[0036] The heat resistant metallic material of the inner form 5 may be form stable when heated during operation of the furnace 1, such as to temperature between 1000°C and 1200°C, preferably even when heated to a temperature between 1200°C and 1400°C. As such, deformation of the flue passage 8 may be avoided.

[0037] The heat resistant metallic material may be chemically stable when heated to a temperature of operation of the furnace 1, such as to temperature between 1000°C and 1200°C, preferable even when heated to a temperature between 1200°C and 1400°C. As such, the deterioration of the flue passage 8 and emittance of gases potentially harmful for the surrounding refractory material may be avoided.

[0038] Fig. 2 depicts a schematic side view of a refractory wall 2 according to an example embodiment of the present invention. Here, the refractory wall 2 of the furnace 1 is a brick wall, but it could also be any other type of refractory wall 2, such as a wall already made in a refractory castable material. A cut out of an internal side of the wall portion 3, repaired or intended to be repaired, is shown. Flue passages 8 can be seen, having vertical portions 8a extending in a vertical direction inside the wall 2 as such, as well as horizontal portions 8b extending in horizontal direction along the extension of the wall 2 and connecting portions 8c therebetween. The horizontal portions 8b and connecting portions 8b of the flue passages 8 may be integrated into a floor portion (not illustrated) of the furnace 1, also commonly called corbel.

[0039] Here, the wall portion 3 can be seen extending in a vertical direction covering the full height of the flue passage 8. The new wall portion 3 may be formed in one piece by completion of steps a) to d). The wall portion 3

may be formed in one piece by using a single inner form 5 and a single outer form 4 to define the shape of the wall portion 3, after which refractory castable material is added by casting into the volume formed between the forms 4, 5, thereby forming the new wall portion 3. The forms 4, 5 may also be made by several portions that has been joined together. The outer form 4 may for instance be made from several fibre boards etc to build up to the height required for forming the wall portion 3. The wall portion 3 may also be formed in sections being stacked on top of each other after the previous section has been cured.

[0040] In an embodiment of the invention, the inner form 5 has a telescopic construction. Thereby, a more flexible inner form 5 is provided that can be easily adjusted to fit the conditions of the wall portion 3 to be repaired.

[0041] Fig. 3 depicts a schematic top view of a furnace 1 according to an example embodiment of the present invention.

[0042] Here, the furnace 1 is a coke furnace 1. The furnace 1 has two chambers 10 intended for heating coke in between three walls 2a, 2b, 2c. The wall 2b in the middle is being repaired *in situ*, showing outer forms 4 defining a new wall portion 3, and an inner form 5 defining new flue passages 8 within the new wall portion 3. The forms 4, 5 define a volume into which a refractory castable material, constituting a main portion 7 of the new wall portion, has been added. In fig. 3, the step (d) of removing the outer form 4 has not yet been carried out. In other words, to fully complete the repair method, the outer form 4 has to be removed before operation of the furnace 1. The outer form 4 may be removed by burning it, such during heating of the wall 3 as it is taken into operation again. This may particularly be that case when the outer form 4 is made from a wooden material.

[0043] The outer form 4 is illustrated having a U-shaped form extending around an edge portion of the refractory wall 2 to be repaired. The outer form 4 may also be two separate outer forms 4 positioned on opposite sides of the wall portion 3, which could be the case if the wall portion 3 to be repaired is not an edge portion, but having remaining refractory wall 2 portions on each side of the wall portion 3 to be repaired. The outer form 4 may also comprise only one outer form 4 along the wall portion 3 to be repaired. This could be the case when only one side of the wall portion 3 needs repair.

[0044] Further, heat insulating material 9 can be seen placed along the walls 2a, 2b, 2c around the area of the wall portion 3 being repaired so as to insulate the walls 2a, 2c, and the remainder of the wall 2b being repaired, during the repair of the refractory wall 2b. Typically, coke is produced in a coke furnace 1 battery which includes a plurality of side-by-side coking chambers 10 or ovens which are separated from each other by walls extending the full length of the chambers 10. A typical coke furnace 1 installation might include, for example 30 to more than 100 individual coking chambers 10 or ovens arranged side-by-side. As such, the furnace 1 in fig. 3 shows only

a part of a larger coke furnace 1 having more chambers (not illustrated) extending along the outmost walls 2a, 2c as well. By using insulating material 9 along the walls 2a, 2b, 2c blocking the heat generated from the walls 2a, 2b, 2c in operation, the repair can be performed *in situ* while the other chambers (not illustrated) maintain in operation, enabling uptime and increased productivity of the furnace 1.

[0045] Fig. 4 depicts a schematic cross-sectional top view of a wall portion 3 according to an example embodiment of the present invention.

[0046] The wall portion 3 comprises a main portion 7 made from a refractory castable material, and an inner form 5 in contact with the main portion 7. The inner form 5 delimits a flue passage 8 of the refractory wall 2 portion, and the inner form 5 is made from a heat resistant metallic material.

[0047] In an embodiment of the invention, the wall portion 3 can be pre-fabricated. This way, not as much refractory castable material needs to be added *in situ*, thereby reducing the material that needs to be cured, consequently reducing the time needed for repair. Also, complex shapes can be made off-site, ensuring fit and quality already before the part of the furnace 1 is shut down for maintenance and repair, thereby reducing the risk of errors and prolonged shut down of the furnace 1.

[0048] In fig. 4, the heat resistant metallic material of the inner form 5 is illustrated with a protective surface oxide layer 6. The protective surface oxide layer 6 may be formed when the material is heated to a temperature of operation of the furnace 1, such as when heated to 1000°C. As such, the layer may not be formed until the wall portion 3 is installed in the furnace 1 and taken in operation. The wall portion 3 may though be pre-heated to form this layer already before the installation in the furnace 1. The protective surface oxide layer 6 may also be of a type that is formed without the need to be heated, such as a protective surface oxide layer 6 formed simply by the exposure of the heat resistant metallic material to oxygen.

[0049] The heat resistant metallic material may for example be an aluminium containing alloy that forms a protective Al_2O_3 surface layer 6 when heated to a temperature of operation of the furnace 1, such as when heated to 1000°C. For example, the heat resistant metallic material may be a ferritic iron-chromium-aluminium alloy (FeCrAl). The ferritic iron-chromium-aluminium alloy (FeCrAl) may comprise, in percent by weight:

- 19-25% Cr, preferably 20-22% Cr
- 3-7% Al, preferably 4-6% Al
- optionally 1-5% Mo, preferably 2-4% Mo
- optionally maximum 0.1% C, preferably maximum 0.08% C
- optionally maximum 1% Si, preferably maximum 0.7% Si
- optionally maximum 0.5% Mn, preferably maximum 0.4% Mn

- balance Fe and unavoidable impurities.

[0050] Such an alloy is suitable for use as an inner form 5 material as it is both form stable, chemically stable and forms a protective protective Al_2O_3 surface layer 6 when heated to temperature of operation of the furnace 1.

[0051] It is to be understood that the present invention is not limited to the embodiments described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the appended claims.

Claims

1. A method for repairing a refractory wall (2) of a furnace (1) by replacing at least a wall portion (3) thereof, the method comprising steps of:

- (a) demolishing the wall portion (3);
- (b) installing an outer form (4) defining a new wall portion (3) *in situ*, and an inner form (5) defining a new flue passage within the new wall portion (3);
- (c) adding a refractory castable material within a volume defined by the outer form (4) and the inner form (5) and allowing the material to cure;
- (d) removing the outer form;

characterized in that

the inner form (5) is made from a heat resistant metallic material.

2. The method of claim 1, wherein the heat resistant metallic material is form stable when heated during operation of the furnace, such as to temperature between 1000°C and 1200°C, preferably even when heated to a temperature between 1200°C and 1400°C.
3. The method according to any one of the preceding claims, wherein the heat resistant metallic material is chemically stable when heated to a temperature of operation of the furnace, such as to temperature between 1000°C and 1200°C, preferable even when heated to a temperature between 1200°C and 1400°C.
4. The method according to any one of the preceding claims, the heat resistant metallic material forms a protective surface oxide layer (6) when heated to a temperature of operation of the furnace, such as when heated to 1000°C.
5. The method according to any one of the preceding claims, wherein the heat resistant metallic material is an aluminium containing alloy that forms a protective Al_2O_3 surface layer (6) when heated to a tem-

perature of operation of the furnace, such as when heated to 1000°C.

6. The method of according to any one of the preceding claims, wherein the heat resistant metallic material is a ferritic iron-chromium-aluminium alloy (FeCrAl). 5
7. The method according to any one of the preceding claims, wherein the heat resistant metallic material is a ferritic iron- chromium-aluminium alloy (FeCrAl) comprising, in percent by weight: 10
 - 19-25% Cr, preferably 20-22% Cr
 - 3-7% Al, preferably 4-6% Al
 - optionally 1-5% Mo, preferably 2-4% Mo 15
 - optionally maximum 0.1% C, preferably maximum 0.08% C
 - optionally maximum 1% Si, preferably maximum 0.7% Si
 - optionally maximum 0.5% Mn, preferably maximum 0.4% Mn 20
 - balance Fe and unavoidable impurities.
8. The method according to any one of the preceding claims, wherein the new wall portion (3) is formed in one piece by completion of steps a) to d). 25
9. The method according to any one of the preceding claims, wherein the refractory castable material is a silica- and/or alumina-based material. 30
10. The method according to any one of the preceding claims, wherein the inner form (5) has a telescopic construction. 35
11. The method according to any one of the preceding claims, wherein the refractory wall (2) is a brick wall.
12. The method according to any one of the preceding claims, wherein the furnace (1) is a coke furnace. 40
13. A wall portion (3) for a furnace (1), the wall portion (3) comprising a main portion (7) made from a refractory castable material, and an inner form (5) in contact with the main portion (7), the inner form (5) delimiting a flue passage of the refractory wall portion, **characterized in that** the inner form (5) is made from a heat resistant metallic material. 45

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14. A furnace (1) comprising a wall portion (3) according to claim 13.
15. The furnace (1) according to claim 14, wherein the furnace (1) is a coke furnace. 55

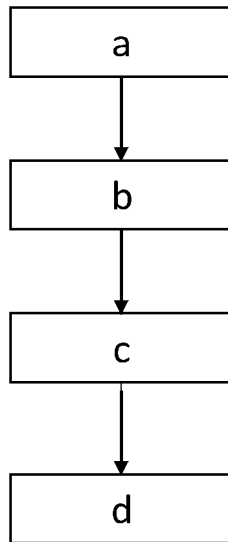


Fig. 1

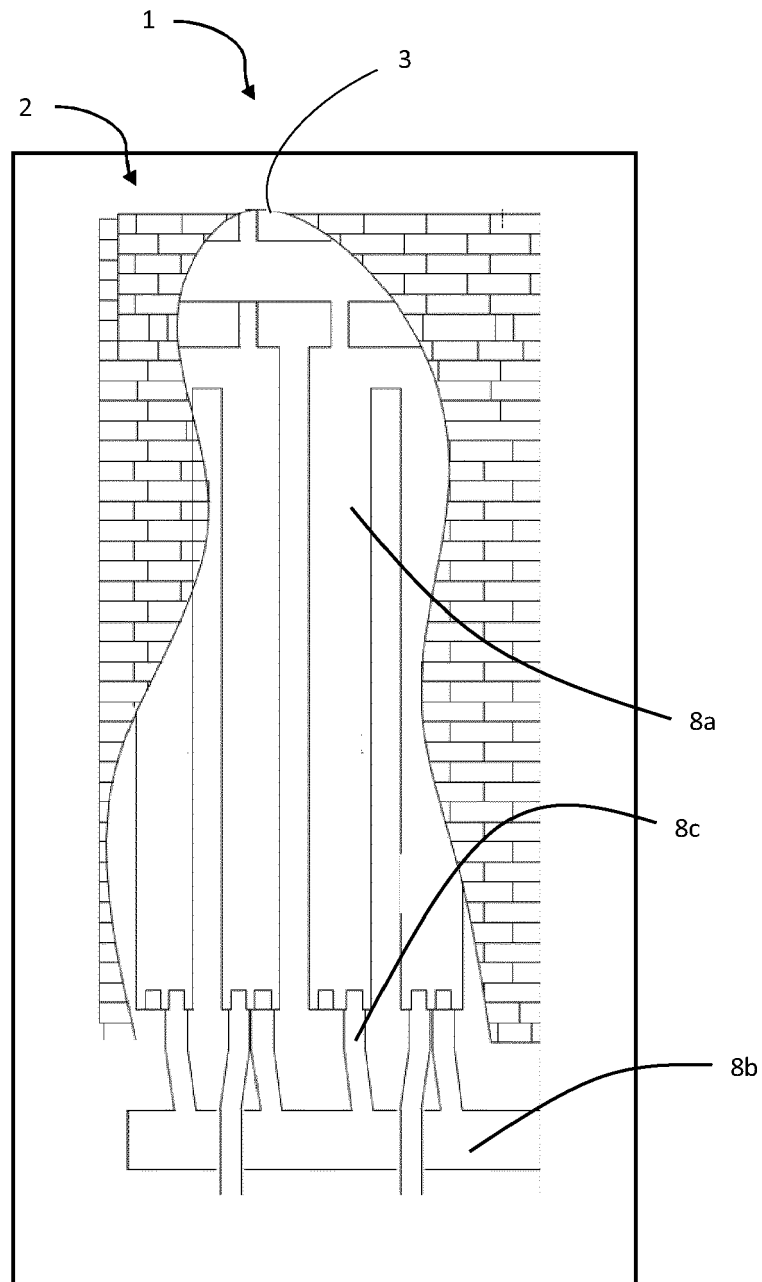


Fig. 2

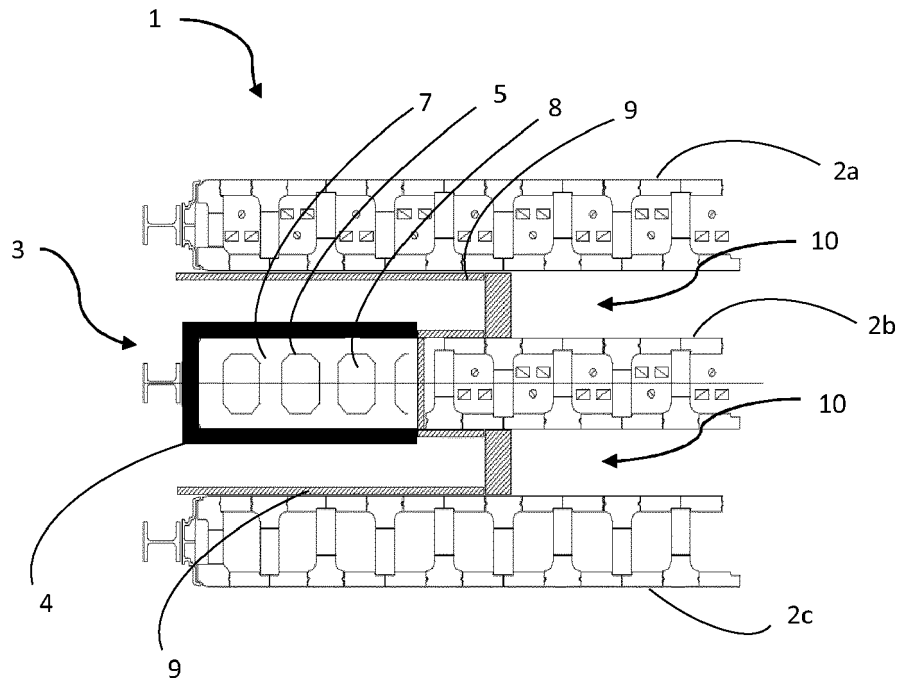


Fig. 3

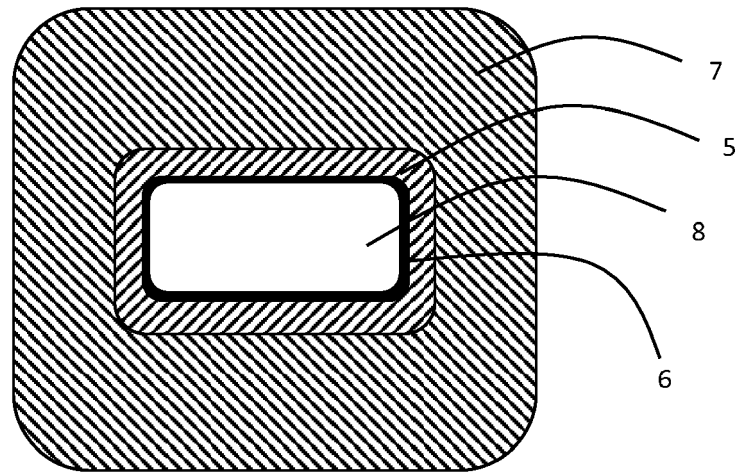


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 21 18 4091

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2009/056843 A1 (FOSBEL INTELLECTUAL LTD [GB]; DRAKULICH DAN [US] ET AL.) 7 May 2009 (2009-05-07) * the whole document *	1-15	INV. F27D1/10 F27D1/16
X	US 2 216 983 A (CARL OTTO [US]) 8 October 1940 (1940-10-08) * figures 11-12 *	13-15	
A	US 4 364 798 A (COSTA RICHARD A) 21 December 1982 (1982-12-21) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F27D C10B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 December 2021	Examiner Gavriliu, Alexandru
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 18 4091

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-12-2021

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