(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 631 583 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.08.2013 Bulletin 2013/35

(51) Int Cl.:
F27D 5/00 *(2006.01)*

(21) Application number: **12290064.0**

(22) Date of filing: **24.02.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) Kiln furniture cassettes and assembly

(57) The invention according to the present application provides kiln furniture assemblies for supporting ceramic objects to be fired in a kiln, comprising first, second and/or third kiln furniture cassettes an engaging connection with each other. The first, second and third kiln furniture cassettes comprise supporting surfaces for supporting ceramic objects to be fired. The first kiln furniture cassettes comprise a plurality of feet extending from the edges on opposite and parallel sides of said supporting surfaces in a direction substantially perpendicular to said supporting surface, which feet comprise one or several recesses/extensions, which may act as female/male engagement portions for appropriately shaped male/female counterparts. The second kiln furniture cassettes comprise one or several extensions/recesses on the edges on opposite and parallel sides the supporting surfaces, and the extensions/recesses may act as male/female engagement portions for appropriately shaped female/male counterparts. The third kiln furniture cassettes comprise one or several feet extending from one edge of said supporting surfaces in a direction substantially perpendicular to said supporting surface, which feet comprise one or several recesses/extensions, which may act as female/male engagement portions for appropriately shaped male/female counterparts, and wherein the supporting surface situated opposite and parallel to said feet comprises one or several recesses or extensions, wherein said recesses and extensions may act as female/male engagement portions for appropriately shaped corresponding male/female counterparts

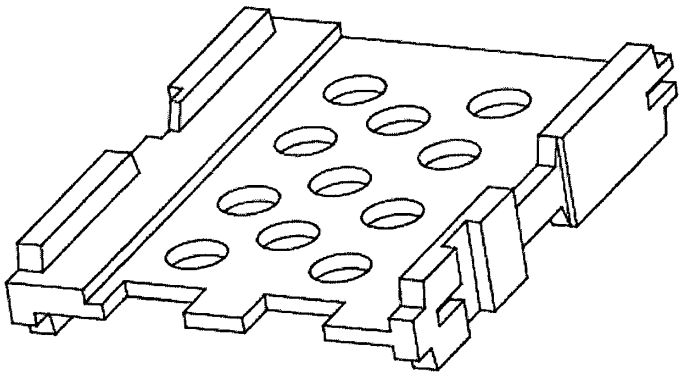

Fig. 3a

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to refractory kiln furniture items for supporting products to be fired, in particular, kiln furniture cassettes, kits of parts and assemblies thereof. The invention further relates to a method of assembling kiln furniture cassettes and the use of such kiln furniture cassettes, assemblies and kits of parts.

BACKGROUND OF THE INVENTION

[0002] In the production process of ceramic products, ceramic product precursors, the so-called green ceramic products, are submitted to a firing operation in a firing kiln. Firing temperatures usually reach levels of 950°C to 1180°C and the duration for heating up, soaking time and cooling down may be between 8 and 20 hours. In order to avoid deformation through softening of the green ceramic products during firing, such products are commonly supported on refractory kiln furniture cassettes. Such cassettes are well known in the art and come in a large variety of shapes and sizes, as described e.g. in prior art documents EP 0 965 809 B1, WO 2007/132276 A1, or DE 20 2010 005 560 U1. In the case of relatively heavy regularly shaped objects, such as roofing tiles, H-shaped cassettes are presently preferred, since they offer improved stability and stackability in kilns. Their main advantage is that they allow improved and controlled heat transfer within a kiln. H-shaped cassettes with a substantially rectangular supporting surface for supporting a ceramic object to be fired, and a plurality of feet extending from the edges on opposite and parallel sides of said supporting surface in a direction substantially perpendicular to said supporting surface have been previously described, for example in EP 0 210 911 B1, DE 2009 004 645 U1, or DE 2009 013 354 U1. One possible embodiment of H-shaped cassettes according to the prior art is shown in Fig. 1. The H-shaped cassettes and their feet are shaped such that several cassettes may be stacked on top of each other to form a stable cassette stack, and leaving enough space between the substantially rectangular support portions such that each cassette may support one or several ceramic products to be fired.

[0003] Commonly, H-shaped cassettes are arranged in a kiln by stacking of H-shaped cassettes on top of each other, in a way that enough space is left between the support portions to allow support of objects to be fired thereon, and subsequent juxtaposition of a plurality of stacks of cassettes. Such a regular pattern of arranging identical cassettes of known dimensions allows straightforward calculation of the number of cassettes that fit into a kiln and therefore of single ceramic objects that may be fired in a single firing operation.

[0004] The mass of H-shaped cassettes during firing entirely rests on the cassette feet. The feet of the bottom cassettes in cassette stacks rest on reinforced resting spots on kiln cars for loading and unloading the cassettes with the objects to be fired into the kiln. During use of the cassettes, the feet may get damaged from chipping due to the high loads to be borne by the cassettes and their feet. Furthermore, friction caused by differences in thermal expansion coefficients between the feet and the resting spots of the kiln car on which the feet of the cassettes at the bottom of the stacks rest cause extra strain on and abrasion of the material. Chipping and abrasion at the feet of the cassettes may cause the cassette stacks to become unstable, which is not desirable. The lower cassettes in particular are exposed to high stresses during operation, reducing their lifetime. In economic terms, it is desirable to reuse each cassette as many times as possible.

[0005] During the firing process, heating energy is required for heating all the contents of the kiln, including both the green ceramic objects to be fired and the cassettes. It is therefore desirable to reduce the mass of kiln furniture used as much as possible in relation to the mass of the objects to be fired. A reduced relative mass of cassettes leads to an increased energetic efficiency of the firing process. An effective way of reducing the mass has been described in WO 2009/077589 A1, which discloses a high stability porous refractory material for kiln furniture objects. This does not however address the possibility of reducing the mass of kiln furniture by structural changes that would lead to a requirement for less material.

[0006] The space available in a kiln sets a physical limit to the number of ceramic objects to be fired during each firing operation. It is therefore beneficial to stack the green ceramic products to be fired as closely and efficiently together as possible, while still ensuring that each specific product to be fired is supported on kiln furniture cassettes in order to avoid deformation through softening or damage to the product during the firing process.

[0007] The state of the art therefore constitutes a problem.

SHORT DESCRIPTION OF THE INVENTION

[0008] The above mentioned problems are solved by the invention according to the appended claims. In particular, the problem is solved by kiln furniture cassettes for supporting ceramic objects to be fired in a kiln according to claims 1, 2 and 3, by kiln furniture assemblies for supporting ceramic objects to be fired in a kiln according to claims 9 to 13 and kits of parts according to claims 14 and 15. Also part of the present invention are methods for assembling the kiln furniture cassettes and their use in firing ceramic products in a kiln.

[0009] The invention also relates to the following aspects:

[0010] A method of formation of an assembly for supporting ceramic objects to be fired in a kiln, comprising the step of assembling n kiln furniture cassettes of claim 1 or claims 4 to 8 when dependent on claim 1 and n-1

kiln furniture cassettes of claim 2 or of claims 5 to 8 when dependent on claim 2 in an alternating arrangement by engagement of their respective male and female engagement portions, and optionally the step of stacking a plurality of the formed assemblies on top of each other, n being an integer of 2 or more.

[0011] A method of formation of an assembly for supporting ceramic objects to be fired in a kiln, comprising the step of assembling a first kiln furniture cassette of claim 1 or claims 4 to 8 when dependent on claim 1 with one or several kiln furniture cassette of claim 3, or of claims 4 to 8 when dependent on claim 3, wherein the first kiln furniture cassette is situated at one extremity of the assembly.

[0012] The use of a kiln furniture cassette or of a kiln furniture assembly or of a kit of parts as described or claimed herein for firing ceramic products in a kiln

[0013] In particular, the various types of kiln furniture cassettes according to the present invention represent modules for assembly comprising female and male parts respectively, in order to form the kiln furniture assemblies of claims 9 to 13.

[0014] In a first aspect of the present invention, there are provided first kiln furniture cassettes for supporting ceramic objects to be fired in a kiln, comprising a supporting surface for supporting a ceramic object to be fired, and one or several feet extending from the edges on opposite and parallel sides of said supporting surface in a direction substantially perpendicular to said supporting surface, and wherein said feet comprise one or several recesses which may act as female engagement portions for appropriately shaped corresponding male counterparts. Alternatively, the feet may comprise one or several extensions which may act as male engagement portions for appropriately shaped corresponding female counterparts.

[0015] The feet of the first kiln furniture cassettes according to the present invention may be shaped such that several of the cassettes may be stably stacked on top of each other. The feet may have flat upper and lower surfaces. The sizes and shapes of the feet are such that when several cassettes are stacked on top of each other, they form a stable cassette stack leaving enough space between the support portions such that each cassette may support one or several ceramic products to be fired.

[0016] In a second aspect of the present invention, there are provided second kiln furniture cassettes for supporting ceramic objects to be fired in a kiln, comprising a supporting surface for supporting a ceramic object to be fired and one or several extensions extending from the edges on opposite and parallel sides of said supporting surface, and wherein said extensions may act as male engagement portions for appropriately shaped corresponding female counterparts. Alternatively, the supporting surfaces may comprise and one or several recesses in their edges on opposite and parallel sides of said supporting surfaces, wherein said recesses may act as female engagement portions for appropriately shaped corresponding male counterparts.

[0017] In a third aspect according to the present invention, there are provided third kiln furniture cassettes for supporting ceramic objects to be fired in a kiln, comprising a supporting surface for supporting a ceramic object to be fired and one or several feet extending from one edge of said supporting surface in a direction substantially perpendicular to said supporting surface, wherein said feet comprise one or several recesses which may act as female engagement portions for appropriately shaped male counterparts, and wherein the edge of the supporting surface situated opposite and parallel to said feet comprises one or several extensions, wherein said extensions may act as male engagement portions for appropriately shaped corresponding female counterparts. Alternatively, the feet may comprise one or several extensions and the edge of the supporting surface situated opposite and parallel to said feet comprises one or several recesses, such that the extensions and recesses may act as male and female engagement portions for appropriately shaped corresponding female and male counterparts. In an embodiment, the one or several feet of the third kiln furniture cassette according to the present invention are shaped such that when several third kiln furniture cassettes are stably assembled, the feet allow stable stacking of the assemblies on top of each other. The feet may have flat upper and lower surfaces.

[0018] The first, second and third kiln furniture cassettes according to the present invention may have perforated supporting surfaces, which allow supporting of products with complex shapes such that they may be borne by several supporting surfaces. Furthermore, the perforations allow handling of the kiln furniture cassettes when hot using specialised equipment. The supporting surfaces of the said kiln furniture cassettes may have a substantially rectangular shape.

[0019] The first, second and third kiln furniture cassettes according to the present invention may have their supporting surfaces designed to receive one or several inlays in order to adapt its shape to a product to be fired.

[0020] The first, second and third kiln furniture cassettes according to the present invention may be made of a ceramic material. A suitable ceramic material may be selected from aluminosilicate ceramics, cordierite, mullite and silicon carbide, or any combination thereof. In an embodiment, the said kiln furniture cassettes comprise a ceramic matrix and ceramic microspheres. The said kiln furniture cassettes may be produced by use of a pressing technology, by use of a casting technology, or by a combination of both.

[0021] In one embodiment of the present invention, the described kiln furniture cassettes for supporting ceramic objects to be fired in a kiln have their recesses or extensions respectively shaped such that they are suitable for retaining two kiln furniture cassettes together when in engagement with their respective counterparts.

[0022] The first, second and third kiln furniture cassettes according to the present invention are shaped

such that they are engageable and disengageable, and when a number of kiln furniture cassettes according to the first, second and/or third aspects of the present invention are connected together in an engaging fashion, they may form a kiln furniture assembly for supporting a plurality of ceramic objects to be fired in a kiln. Such an assembly may comprise n kiln furniture cassettes according to the first aspect of the present invention and n-1 kiln furniture cassettes according to the second aspect of the present invention, engaging each other in an alternating linear arrangement, n being an integer of 2 or more. In that case, the cassettes at both extremities of the assembly will always be first kiln furniture cassettes, which each comprise a plurality of feet. Alternatively, an assembly according to the present invention may comprise one kiln furniture cassette according to the first aspect of the present invention at one extremity in positive engagement with a series of any number of engaged kiln furniture cassettes according to the third aspect of the present invention. Any other stable assembly of a combination of first, second and/or third kiln furniture cassettes in engagement also forms part of the present invention.

[0023] A plurality of assemblies as described above may be stacked on top of each other, such that the feet of each kiln furniture cassette according to the first and/or third aspect of the present invention may rest on either the base of the kiln, or on the feet of a kiln furniture assembly below. A plurality of such stacks may be introduced into a kiln for firing green ceramic products in a single firing operation.

[0024] Also part of the present invention are assemblies as described above, further comprising bottom batts for supporting the feet of the bottom kiln furniture cassettes of claim 1 or 4. Said bottom batts act as intermediate elements and are placed in the kiln between the kiln car spots and the feet of the bottom kiln furniture cassettes according to the first aspect of the present invention in the assembly.

[0025] Methods for assembling any of the above mentioned assemblies from kiln furniture cassettes of the present invention also form part of the present invention.

[0026] Also part of the present invention is a kit of parts for assembling a kiln furniture assembly for supporting ceramic objects to be fired in a kiln comprising a plurality of kiln furniture cassettes according to the first aspect of the invention, and at least one kiln furniture cassette according to the second aspect of the invention. Alternatively, the kit may comprise one kiln furniture cassette according to the first aspect of the invention and any number of kiln furniture cassettes according to the third aspect of the invention. Any other kit comprising a number of first, second and third kiln furniture cassettes that may be assembled to form a stable assembly also forms part of the present invention.

[0027] The use of any of the kiln furniture cassettes, of any of the kiln furniture assemblies, and of any kit of parts as described herein also forms part of the invention according to the present application.

[0028] When using the kiln furniture cassettes, the kiln furniture assemblies, and the kit of parts of the present invention, the ratio of the total mass of the kiln furniture items compared to the mass of the ceramic objects to be burned is reduced compared to the state of the art. Furthermore, the kiln furniture assemblies according to the present invention take less space when used for firing of products in a kiln than kiln furniture cassettes according to the state of the art. Therefore, more ceramic objects may be introduced into the kiln at any one time, allowing for larger batches of ceramic objects to be fired per firing operation.

[0029] Furthermore, the number of feet resting on other contact surfaces, such as other cassette feet or the base of the kiln is reduced compared to the H-cassettes according to the state of the art. This leads to a reduction in abrasion on the cassettes and improves the overall reusability of the cassettes. The modular assembly comprising only two types of modules (kiln furniture cassettes according to the first and second aspects of the present invention) allows easy replacement of modules when abrasions, chipping or other types of damage occur that may lead to a reduction in the stability of the assembly.

SHORT DESCRIPTION OF THE FIGURES

[0030] The invention will be further illustrated by reference to the following figures:

- Fig. 1 shows a simplified perspective view of a H-cassette according to the state of the art;
- Fig. 2a shows a simplified front view of three H-cassettes according to the state of the art in a standard arrangement for introducing into a kiln when firing ceramic products;
- Fig. 2b shows a simplified perspective view of the arrangement of Fig. 2a;
- Fig. 3a shows a simplified perspective view of a kiln furniture cassette according to the first aspect of the present invention;
- Fig. 3b shows a simplified perspective view of a kiln furniture cassette according to the second aspect of the present invention;
- Fig. 4 shows how a kiln furniture cassette according to the first aspect of the present invention and a kiln furniture cassette according to the second aspect of the present invention may be combined by engaging connection according to the method of the present invention;
- Fig. 5a shows a simplified front view of two kiln furniture cassettes according to the first aspect of the present invention and one kiln furniture cassette according to the second aspect of the present invention, engaged with each other in an alternating arrangement;
- Fig. 5b shows a simplified perspective view of the arrangement of Fig. 5a;

Fig. 6 shows a simplified perspective view of the arrangement of Fig. 5a in combination with bottom batts for supporting the kiln furniture assembly according to the present invention in a kiln.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The present invention according to the appended claims provides kiln furniture cassettes and kiln furniture assemblies for supporting green ceramic objects during firing in order to prevent deformation through softening and abrasion of the green ceramic objects during firing. The ceramic objects to be fired may be heavy clay roofing tiles.

[0032] The present invention provides first, second and third kiln furniture cassettes, which may be assembled in order to form kiln furniture assemblies. Exemplary embodiments of the first and second kiln furniture cassettes are shown in Figs. 3a and 3b respectively.

[0033] The first kiln furniture cassettes according to the present invention have a structure that is similar to the structure of state of the art H-type kiln furniture cassettes shown in Fig. 1. In particular, the first kiln furniture cassettes are intended for supporting ceramic objects to be fired in a kiln and comprise a supporting surface for supporting a ceramic object to be fired, and a plurality of feet extending from the edges on opposite and parallel sides of said supporting surface in a direction substantially perpendicular to said supporting surface. The first kiln furniture cassettes are characterised in that their feet comprise one or several recesses which may act as female engagement portions for appropriately shaped male counterparts. Alternatively, the feet may comprise one or several extensions which may act as male engagement portions for appropriately shaped corresponding female counterparts. When in use, the first kiln furniture cassettes are intended to be oriented such that the supporting surfaces are substantially horizontal and the feet extend substantially vertically in both directions from opposite edges of the supporting surfaces.

[0034] The second kiln furniture cassettes according to the present invention do not comprise any feet nor any other means for independently supporting the cassettes. They comprise a supporting surface for supporting a ceramic object to be fired and one or several extensions extending from the edges on opposite and parallel sides of said supporting surface. They are characterised in that said extensions may act as male engagement portions for appropriately shaped female counterparts. Alternatively, the supporting surfaces may comprise and one or several recesses in their edges on opposite and parallel sides of said supporting surfaces, wherein said recesses may act as female engagement portions for appropriately shaped corresponding male counterparts. When in use, the second kiln furniture cassettes are intended to be oriented such that the supporting surfaces are substantially horizontal.

[0035] The third kiln furniture cassettes according to the present invention may be considered a combination of the first and second kiln furniture cassettes, in that they only have one or several feet extending from one of the edges of the supporting surface in a direction substantially perpendicular to said supporting surface. The said feet comprise one or several recesses which may act as female engagement portions for appropriately shaped male counterparts, and the edge of the supporting surface located opposite and parallel to the edge from which the feet extend comprises one or several extensions, which may act as male engagement portions for appropriately shaped female counterparts. Alternatively, the feet may comprise one or several extensions which may act as male engagement portions for appropriately shaped corresponding female counterparts, and the edge opposite may comprise one or several recesses, which may act as female engagement portions for appropriately shaped male counterparts. When in use, the third kiln furniture cassettes are intended to be oriented such that the supporting surfaces are substantially horizontal and the one or several feet extend substantially vertically in both directions from one edge of the supporting surfaces.

[0036] The supporting surfaces of the first, second and third kiln furniture cassettes may be substantially rectangular, in order to allow easy stacking and arranging of the cassettes in a kiln.

[0037] The one or more recesses (or extensions, as the case may be) on the first kiln furniture cassettes and the one or more extensions (or recesses, as the case may be) on the second kiln furniture cassettes may be shaped such that the first and second kiln furniture cassettes may be easily assembled by positive engagement of the one or more (male) extensions of the second (or first) kiln furniture cassettes with respective (female) recesses of the first (or second) kiln furniture cassettes. The recesses and extensions on opposite ends of the first and second kiln furniture cassettes respectively may have different shapes and arrangements, such that only one end of a second kiln furniture cassette may be connected to a particular end of a first kiln furniture cassette. Figs. 3a and 3b show examples of shapes of recess/extension-combinations that may form an engaging connection.

[0038] Additionally, the one or more recesses or extensions on a first kiln furniture cassette and the one or more extensions and recesses on a third kiln furniture cassette may be shaped such that the first and third kiln furniture cassettes may be easily assembled by positive engagement of the one or more extensions or recesses of the third kiln furniture cassettes with respective recesses or extensions of the first kiln furniture cassettes.

[0039] In general, any assembly formed by a combination of first, second and/or third kiln furniture cassettes according to the present invention that may form a stable assembly for supporting ceramic objects to be fired in a kiln forms part of the present invention.

[0040] As part of the present invention, any extensions and recesses with shapes that allow secure engagement of the first, second and/or third kiln furniture cassettes may be provided. Fig. 4 schematically shows an example of how a second kiln furniture cassette may engage with a first kiln furniture cassette according to the present invention.

[0041] In one embodiment of the present invention, the extensions and recesses are shaped such that they allow retaining of two kiln furniture cassettes together when in engagement with their respective counterpart. This type of connection provides added stability to the assemblies according to the present invention.

[0042] The first, second and third kiln furniture cassettes may be made of any material suitable for use in a kiln, as commonly known to the skilled person in the art. They may be made of a ceramic material, such as a ceramic refractory material. As mentioned above, the ratio of the mass of the kiln furniture compared to the mass of the products to be fired may be reduced as much as possible. Therefore it is advantageous to use a lightweight ceramic material, such as a material comprising a ceramic matrix and ceramic microspheres, as disclosed in international patent application published under WO 2009/077589 A1. In one embodiment, the material of the said kiln furniture cassettes according to the present invention may comprise a ceramic such as an aluminosilicate ceramic, cordierite, mullite and silicon carbide and/or any combination thereof. The said kiln furniture cassettes may be made of the same material, in order to avoid a difference in thermal expansion coefficients between the materials, which may lead to increased abrasion and strain at the engaging recesses and extensions of the first and second kiln furniture cassettes respectively, which would reduce the stability of the assembly as a whole and shorten he lifetime of the said kiln furniture cassettes.

[0043] The advantages of the present invention become clear when considering an assembly of first, second and/or third kiln furniture cassettes. The method of formation of a kiln furniture assembly for supporting ceramic objects to be fired in a kiln also forms part of the present invention. In order to form such an assembly, in one embodiment, a first kiln furniture cassette and a second kiln furniture cassette are assembled by engaging extensions of a second kiln furniture cassette with corresponding recesses of a first kiln furniture cassette, as exemplified in Fig. 4. Then the extensions of the second kiln furniture cassette on the opposite end of the extensions already engaged into the recesses of a first kiln furniture cassette are connected by positive engagement into a further first kiln furniture cassette, through its corresponding recesses. Next, a further second kiln furniture cassette is connected by positive engagement into the further first kiln furniture cassette, and so on until an assembly of first and second kiln furniture cassettes of the desired size is formed. Alternatively, the first kiln furniture cassettes may have extensions and the second kiln furniture cassettes may have ecesses, but the method of formation of the assembly remains the same. The kiln furniture cassettes at both ends of the assembly formed are first kiln furniture cassettes. In this way, an assembly of first and second kiln furniture cassettes is formed, comprising n first kiln furniture cassettes and n - 1 second kiln furniture cassettes, n being an integer of 2 or more. The assembly will have n + n-1 = 2n - 1 supporting surfaces for supporting ceramic objects to be fired, n being an integer of 2 or more. An Example of an assembly with n = 2 is shown in Fig. 5a and 5b.

[0044] In a further embodiment, a first kiln furniture cassette may be connected to a third kiln furniture cassette by engagement of extensions on the edge of the supporting surface of the third kiln furniture cassette that does not have one or several feet protruding from it, with recesses in the feet on one edge of said first kiln furniture cassette. Next, another third kiln furniture cassette is engaged using its extensions into the recesses of the third kiln furniture cassette already connected to said first kiln furniture cassette. Any number of third kin furniture cassettes may be added to the assembly. Alternatively, the first and third kiln furniture cassettes have extensions extending from their feet, which are used for secure engagement into recesses on the edges of the supporting surfaces of the third kiln furniture cassettes.

[0045] In general, any assembly formed by a combination of first, second and/or third kiln furniture cassettes according to the present invention that may form a stable assembly for supporting ceramic objects to be fired in a kiln, and any method of assembling first, second and/or third kiln furniture cassettes into such an assembly forms part of the present invention.

[0046] The final size of the assembly of first, second and/or third kiln furniture cassettes may correspond to the greatest possible width at which the assembly may fit laterally into a kiln in which the objects are to be fired.

[0047] The size of the supporting surfaces of the first, second and third kiln furniture cassettes for supporting a ceramic object to be fired may be chosen such that each supporting surface for supporting a ceramic object to be fired may support one object to be fired (such as for examples a heavy clay roofing tile to be fired).

[0048] In the described assemblies, the feet of the first and/or third kiln furniture cassettes bear the load of the supporting surfaces of both first and second kiln furniture cassettes, and the weight of the objects to be fired. The assemblies of first, second and/or third kiln furniture cassettes may be stacked on top of each other up to a desired height. The total height of the stacked assemblies may be chosen such that a maximum of objects to be fired may be introduced into a kiln. The feet of the first and/or third kiln furniture cassettes in the bottom assembly bear the full load of all of the assemblies stacked above. In particular, in an assembly comprising only first and second kiln furniture cassettes, each first kiln furniture cassette bears the load of all the first kiln furniture cassettes stacked above it, as well as half the weight of all the

second kiln furniture cassettes stacked above it on its one side and half the weight of all the second kiln furniture cassettes on its other side stacked above it. Similarly, in an assembly comprising only first and third kiln furniture cassettes, each foot bears the load of one full supporting surface including its load. Therefore, the weight borne by each foot is nearly twice as much compared to the weight borne by H-type cassettes according to the state of the art when used in a stacked conformation. The feet of the first and third kiln furniture cassettes therefore need to be designed such that they can support the mass of all kiln furniture cassette assemblies as well as of the objects to be fired stacked above.

[0049] In a further aspect of the present invention there are provided intermediate elements for placing between the assemblies for supporting ceramic objects to be fired in a kiln and the resting spots of the kiln car (see Fig. 6). These intermediate elements provide extra stability to the bottom first and third kiln furniture cassettes and thereby help avoid rocking and movement of the assembly, which might otherwise lead to disengagement of kiln furniture cassettes in the stacked assemblies. The said intermediate elements are constituted by two elongated supporting members, which extend under the feet of said first kiln furniture cassettes, connected by a plurality of crossbars to hold the elongated supporting members in position. The intermediate elements may be made of the same material as the first and second kiln furniture cassettes of the assembly, in order to avoid a difference in thermal expansion coefficients between the materials, which may lead to increased abrasion and strain at the interfaces between the feet of the first kiln furniture cassettes and the intermediate elements.

[0050] The use of the first, second and third kiln furniture cassettes and of the assemblies and kits of parts according to the present invention leads to improvements in efficiency through the reduced amount of space needed for providing support to each object to be fired in a kiln. The first, second and/or third kiln furniture cassettes when assembled according to the present invention occupy less space than conventional H-shaped cassettes. This means that more objects may be fired in a kiln per firing operation. Alternatively, the same amount of objects as previously may be fired in a smaller kiln.

[0051] Furthermore, the first, second and third kiln furniture cassettes and the assemblies and kits of parts according to the present invention have a lower mass per object to be fired compared to conventional H-shaped cassettes. This is due in particular to the fact the second kiln furniture cassettes according to the present invention have no feet or other supporting elements, and therefore are essentially reduced to a supporting surface, and that the third kiln furniture cassettes according to the present invention only have feet on one edge of their supporting surfaces. Therefore the energy required for heating up the kiln furniture during a firing operation is reduced, leading to further increases in efficiency. This is especially true when the said kiln furniture cassettes are made of specialised highly stable low-weight refractory materials as described above.

[0052] Perforations in the supporting surfaces lead to a further reduction in mass without substantial reduction in stability, and further allow the support of complex shaped objects over several stacked kiln furniture cassettes, as well as the handling of the kiln furniture cassettes with handling equipment when hot. The supporting surfaces may further be designed to receive inlays, which allow them to more securely support certain objects, as described for example in DE 2009 013 354 U1.

[0053] The modular assemblies according to the present invention requiring only two types of modules (the first and second, or the first and third kiln furniture cassettes) improve the serviceability and ease of use of the kiln furniture according to the present invention. In general, kiln furniture cassettes may be reused hundreds of times and only have to be taken out of service when they sustain structural damage from chipping or abrasion, in particular on their feet, which leads to reduced stability of kiln furniture assemblies and cassette stacks. According to the present invention, the second kiln furniture cassettes do not comprise any load bearing elements (no feet), which could be damaged. The feet of the first and third kiln furniture cassettes on the other hand bear a heavier load compared to state of the art cassettes. According to the present invention, the replacement of parts is straightforward, since the first, second and third kiln furniture cassettes have a relatively simple design and may be easily replaced when damaged by disassembling a kiln furniture assembly, disposing of a damaged first, second or third kiln furniture cassette and reassembling an assembly using replacement kiln furniture cassettes.

EXAMPLE

[0054] A standard industrial size kiln for firing ceramic objects is designed for fitting items over a width of approximately 6,500 mm inside. Standard H-shaped cassettes for bearing heavy clay roofing tiles according to the state of the art have an external width (l) of 390 mm. This allows an internal width for each H-type cassette of 350 mm for placing one heavy clay roofing tile. When introduced in a kiln for firing green ceramic products, the H-shaped cassettes are placed next to each other as shown in Fig. 2b. In order to ensure adequate air current and therefore uniform temperature within the kiln, a gap (g) of 12 mm is provided between the juxtaposed H-cassettes. In view of these limitations, the maximum number of H-shaped cassettes that may be juxtaposed during firing of objects is 16, taking up a width of 16×390 mm $+ 15 \times 12$ mm = 6,436 mm.

[0055] First and second kiln furniture cassettes according to the present invention were assembled in order to form a cassette assembly by engaging the extensions of second kiln furniture cassettes with the recesses of the first kiln furniture cassettes. The first kiln furniture cas-

settes according to the present invention have the same width of the H-shaped cassettes of the prior art, 390 mm, which allows an internal width for placing an object to be fired (such as a heavy clay roofing tile) of 350 mm (il). The second kiln furniture cassettes when assembled have a width of 350 mm (il; not including the extensions which are introduced into the corresponding recesses of the first kiln furniture cassettes when assembled), also allowing the support of a heavy clay roofing tile. Furthermore, no gap needs to be left between assembled cassettes. In view of these limitations, the total number of supports which may be juxtaposed in an kiln is 9 first kiln furniture cassettes and 8 second kiln furniture cassettes, allowing the introduction of a total of 17 cassettes next to each other, supporting the same number of heavy clay roofing tiles, taking up a width of 9 $\times$ 390 mm + 8 $\times$ 350 mm = 6,310 mm.

[0056] Since the first and second kiln furniture cassettes according to the present invention have substantially the same total height (h) and length (L) as the H-shaped cassettes according to the prior art, an equivalent number of kiln furniture items may be stacked on top of each other, and an equivalent number of stacks may fit inside a kiln. Therefore the number of heavy clay roofing tiles that may be fired in a single batch for the given kiln is 1/16th (6.25%) higher compared to when H-shaped cassettes according to the state of the art are used.

Claims

1. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln, comprising
   a supporting surface for supporting a ceramic object to be fired, and
   one or several feet extending from edges on opposite and parallel sides of said supporting surface in a direction substantially perpendicular to said supporting surface,
   characterised in that said feet comprise one or several recesses or extensions which may act as female/male engagement portions for appropriately shaped corresponding male/female counterparts.

2. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln, comprising
   a supporting surface for supporting a ceramic object to be fired and
   one or several extensions or recesses extending from or in the edges on opposite and parallel sides of said supporting surface,
   characterised in that said extensions/recesses may act as male/female engagement portions for appropriately shaped corresponding female/male counterparts.

3. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln, comprising
   a supporting surface for supporting a ceramic object to be fired, and
   one or several feet extending from one edge of said supporting surface in a direction substantially perpendicular to said supporting surface,
   characterised in that said one or several feet comprise one or several recesses or extensions which may act as female/male engagement portions for appropriately shaped male/female counterparts and **in that** the edge of the supporting surface situated opposite and parallel to said feet comprises one or several extensions or recesses, wherein said extensions or recesses may act as male/female engagement portions for appropriately shaped corresponding female/male counterparts.

4. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln according to claim 1 or 3, wherein said feet are shaped such that individual cassettes may be stacked on top of each other.

5. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln according to any of the previous claims, wherein the supporting surface has a substantially rectangular shape and/or is perforated.

6. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln according to any of the previous claims, wherein the supporting surface is designed to receive one or several inlays in order to adapt its shape to a product to be fired.

7. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln according to any of the previous claims, wherein the kiln furniture cassette is made of a ceramic material.

8. Kiln furniture cassette for supporting ceramic objects to be fired in a kiln according to any of the previous claims, wherein the recesses or extensions respectively have shapes is suitable for retaining two kiln furniture cassettes together when in engagement with their respective counterpart.

9. Kiln furniture assembly for supporting ceramic objects to be fired in a kiln, comprising kiln furniture cassettes according to any of the previous claims, connected through their engaging male and female portions.

10. Kiln furniture assembly for supporting ceramic objects to be fired in a kiln according to claim 9, comprising n kiln furniture cassettes of claim 1, or of any of claims 4-8 when dependent on claim 1, in an alternating arrangement and in an engaging connection with n-1 kiln furniture cassettes of claim 2, or any one of claims 5-8 when dependent on claim 2, n being an integer of 2 or more.

11. Kiln furniture assembly for supporting ceramic objects to be fired in a kiln according to claim 9, comprising at one extremity one kiln furniture cassette of claim 1, or of any of claims 4 to 8 when dependent on claim 1, connected to one or more kiln furniture cassettes of claim 3, or of any of claims 4 to 8 when dependent on claim 3.

12. Kiln furniture assembly for supporting ceramic objects to be fired in a kiln comprising a plurality of kiln furniture assemblies of any of claims 9 to 11 stacked on top of each other.

13. Kiln furniture assembly for supporting ceramic objects to be fired in a kiln according to claims 9 to 11, further comprising n supporting batts for supporting the feet of the bottom kiln furniture cassettes of claim 1 or 3, or claim 4 to 8 when dependent on claim 1 or 3.

14. Kit of parts for assembling a kiln furniture assembly for supporting ceramic objects to be fired in a kiln comprising a plurality of kiln furniture cassettes according to any one of claims 1 to 8, which may be assembled to form a stable assembly.

15. Kit of parts for assembling a kiln furniture assembly for supporting ceramic objects to be fired in a kiln according to claim 14, comprising

(a) a plurality of kiln furniture cassettes according to claim 1 or any one of claims 4 to 8 when dependent on claim 1, and
(b1) at least one kiln furniture cassette according to claim 2 or any of claims 5 to 8 when dependent on claim ; or
(b2) at least one kiln furniture cassette according to claim 3, or any of claims 4 to 8 when dependent on claim 3.

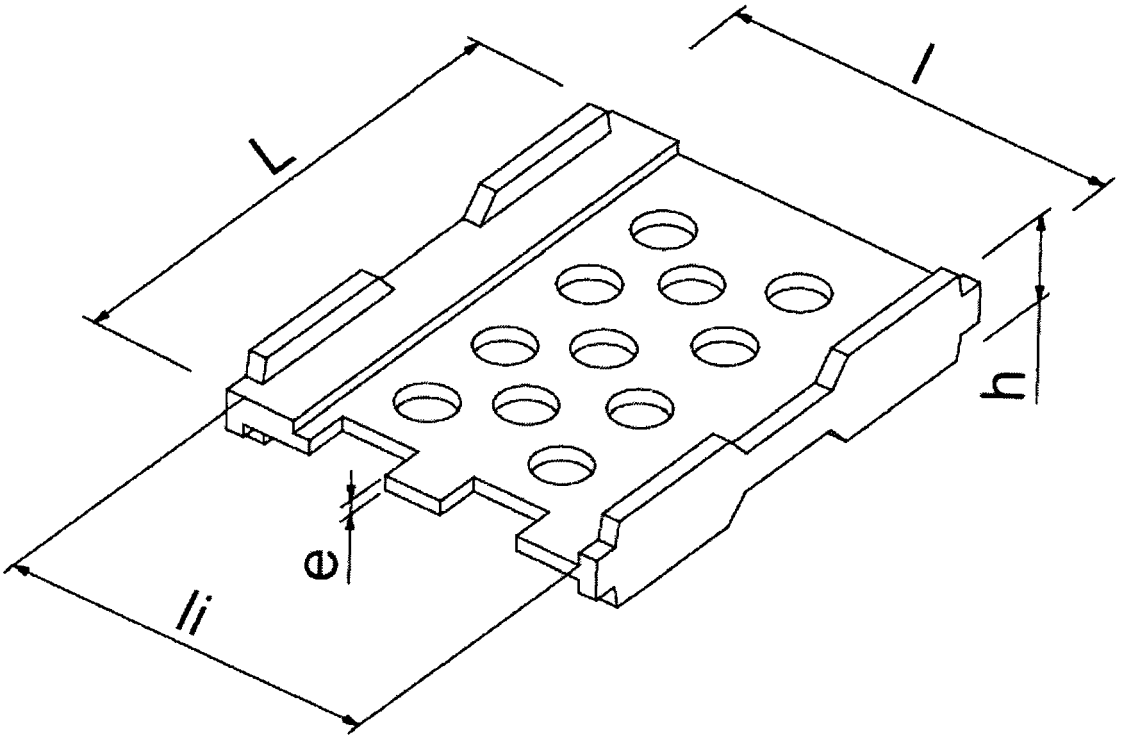

Fig. 1

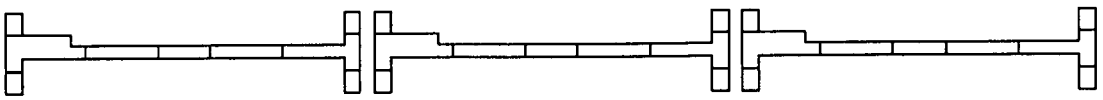

Fig. 2a

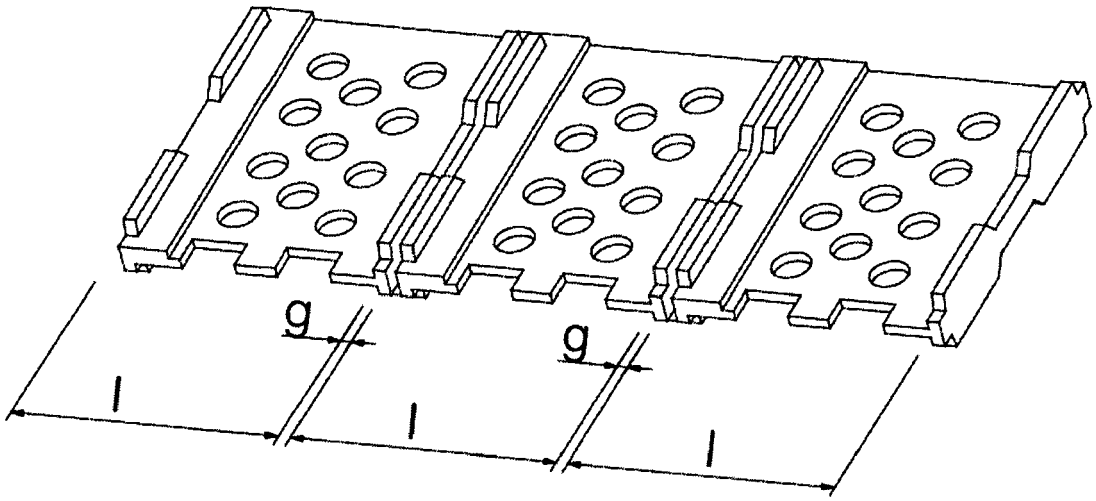

Fig. 2b

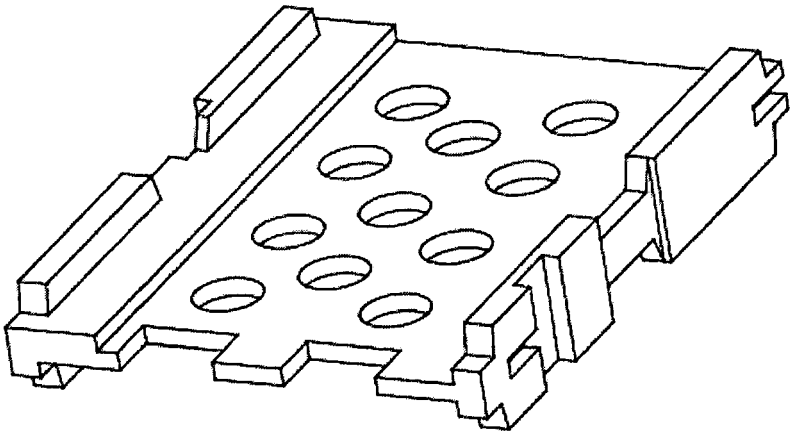

Fig. 3a

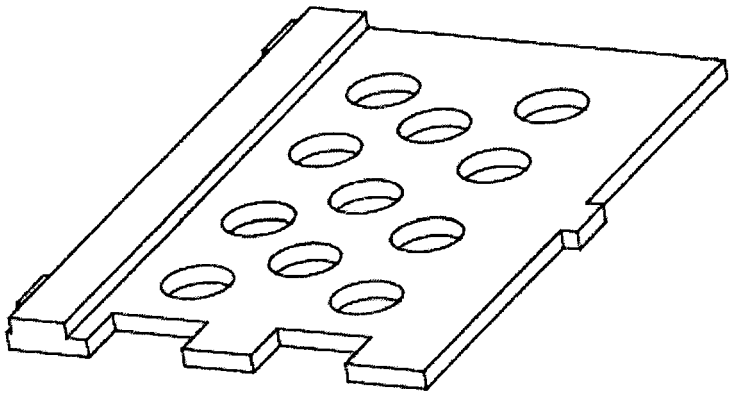

Fig. 3b

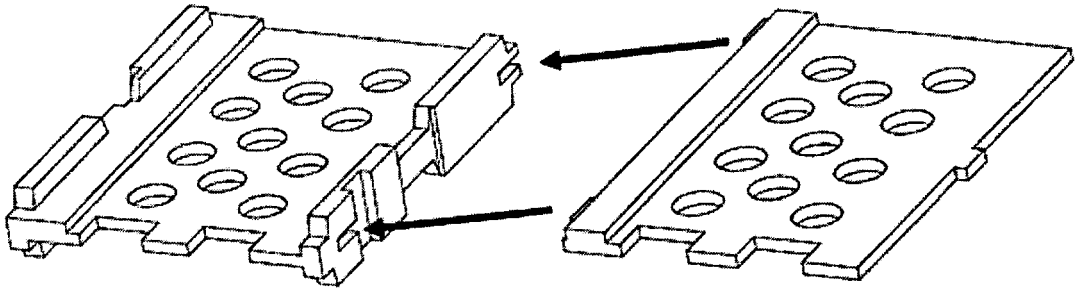

Fig. 4

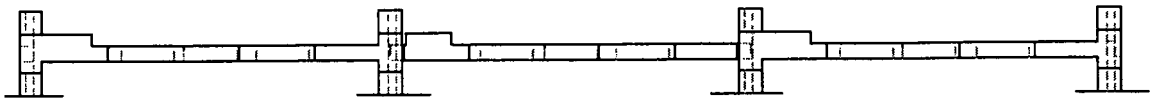

Fig. 5a

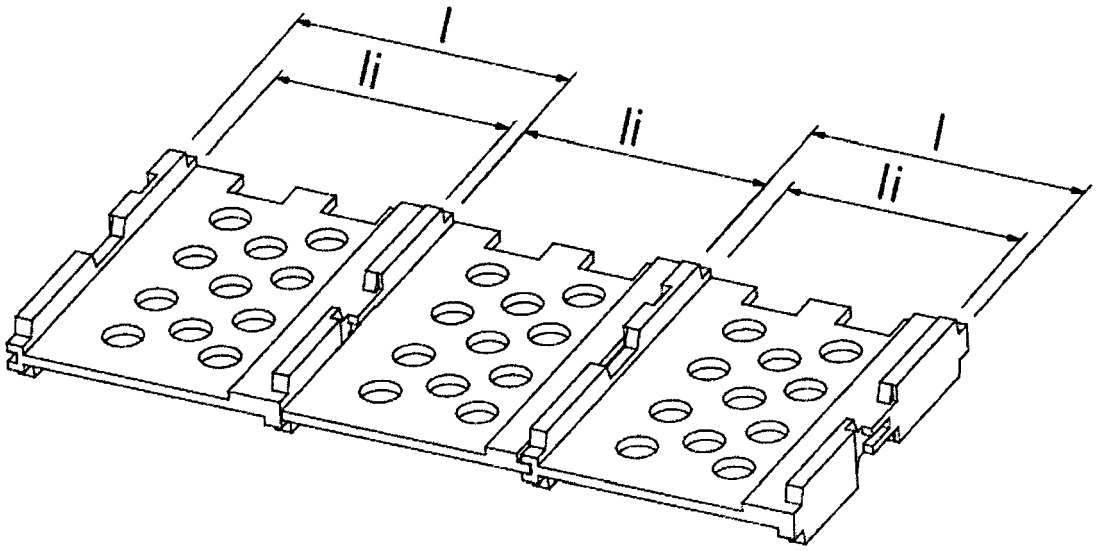

Fig. 5b

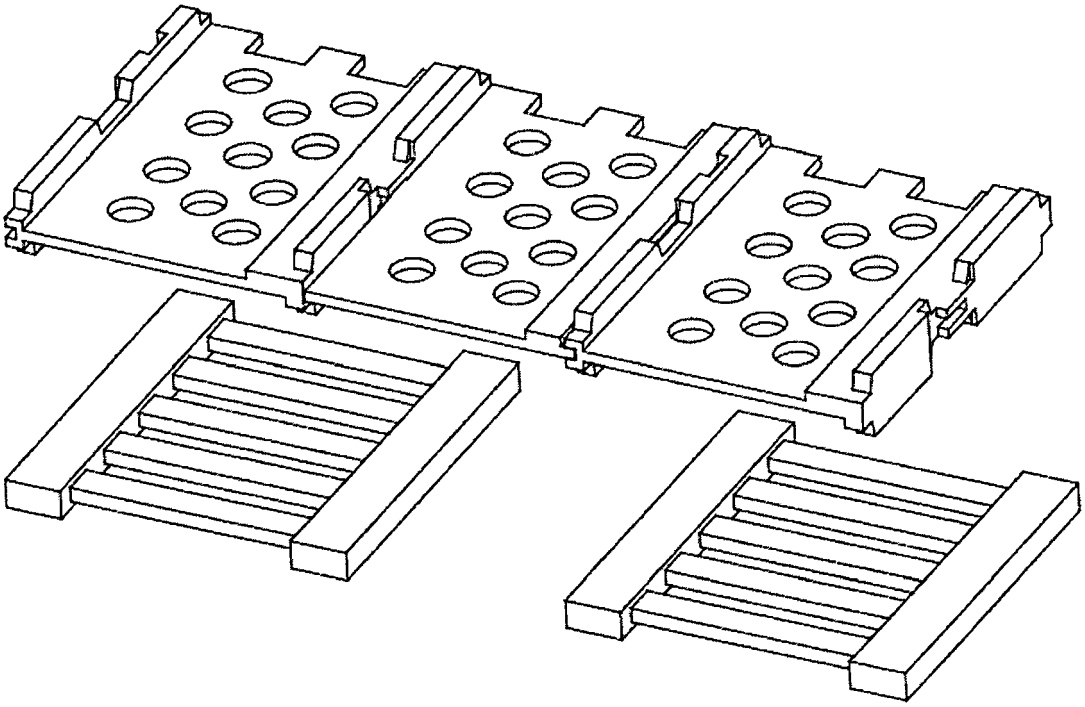

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 12 29 0064

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Place of search	Date of completion of the search	Examiner
Munich	31 July 2012	Gavriliu, Alexandru

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