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

(11) EP 2 612 972 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.01.2015 Bulletin 2015/03

(51) Int Cl.:
E04B 1/86 *(2006.01)*

(21) Application number: **12007457.0**

(22) Date of filing: **31.10.2012**

(54) **Prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, and manufacturing process thereof**

Vorgefertigte Schallisolierung und schallabsorbierende Tafel für Hausbau, Straßen, Tunnels und dergleichen, und Herstellungsprozess davon

Panneau d'isolation sonore préfabriqué et insonorisant pour construction de bâtiment, routes, tunnels et analogues, et son procédé de fabrication

(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

(30) Priority: **03.11.2011 IT TO20111000**

(43) Date of publication of application:
10.07.2013 Bulletin 2013/28

(73) Proprietor: **Risso, Marco**
14100 Asti (AT) (IT)

(72) Inventors:
- **Gallo, Enrico**
  14100 Asti (AT) (IT)
- **Risso, Marco**
  14100 Asti (AT) (IT)
- **Steffenino, Roberto**
  14100 Asti (AT) (IT)

(74) Representative: **Aprà, Mario**
Aprà Brevetti
Via Bertola 2
10121 Torino (IT)

(56) References cited:
EP-A2- 1 088 800 **US-A1- 2010 078 260**

EP 2 612 972 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like. The invention further relates to the process for manufacturing such panel.

[0002] The need of reducing annoying and/or harmful noises is felt not only in the field of civil and industrial building construction but also in that of roads and road and railway tunnels. Document CN101634176A describes a light panel for building constructions comprising an outer layer and an inner core and wherein blast furnace slag is used as component of the outer layer, whereas the inner core is of polystyrene foam. The outer layer of such known panel exhibits sound insulation features. However, the above known panel has quite limited sound insulation features as it exhibits a structure not suitable for carrying out the dual and necessary function of sound insulating barrier and sound absorbing barrier for the effective noise reduction. Moreover, in the above known panel, while the slag is used as sound insulation means, the same is not structurally distributed in an optimal manner, also considering the shape thereof and the grain size thereof, for carrying out, as said, the dual function of sound insulating barrier and sound absorbing barrier.

[0003] Document US-A-2010/0078260 discloses an acoustical barrier material.

[0004] Starting from the notion of the above drawbacks, the present invention aims to solve them.

[0005] An object of the present invention is to provide a prefabricated panel which concurrently provides a sound insulating barrier and a sound absorbing barrier for the effective reduction of annoying and/or harmful noises in building construction, roads, tunnels and the like.

[0006] Another object of the present invention is to provide a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like which is easy to manufacture, has a certain effectiveness and is easy to install.

[0007] Yet another object of the present invention is to provide a process for manufacturing a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like which is quick and easy to manufacture.

[0008] In view of such objects, the present invention provides a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like the fundamental feature whereof is the object of claim 1.

[0009] The essential feature of the process for manufacturing the prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, according to the present invention, is the object of claim 7.

[0010] Further advantageous features are listed in the dependent claims. All the claims are intended as integrally reported herein.

[0011] The present invention will appear more clearly from the following detailed description made with reference to the annexed drawing provided by way of a non-limiting example only, wherein:

- fig. 1 shows a perspective view of an exemplary embodiment of a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, object of the invention;
- fig. 2 shows a perspective enlarged scale view of a tile component of the prefabricated panel according to fig. 1.

[0012] General features of the slag in prefabricated construction panels

[0013] In general, slag is widely used as inert material for prefabricated construction panels also with sound insulation purposes. In such use, it is mixed with other components in a known manner for forming a layer of the panel (CN101634176A). The known literature does not specifically indicate the shape or grain size of the slag used to this end.

[0014] Blast furnace slag (or blast furnace dross) is a by-product of the cast iron manufacturing process during which large amounts of liquid dross are formed having a composition similar to Portland concrete. The dross acquires hydraulic features if, at the exit from the blast furnace, it is suddenly cooled and transformed into porous granules with a vitreous structure (amorphous silica), a material called granular slag. Subsequently, this material is ground so as to obtain a powder having fineness comparable to that of concrete.

[0015] It is important to note that, according to the grain size, the slag has both sound insulating (when in powder state) and sound absorbing properties (when in natural granular state).

[0016] From a construction viewpoint, basic granulated slag is used for making prefabricated panels, which by itself has hydraulic properties, i.e. the capability of hardening in contact with water. However, since such hardening is per se very slow, in order to accelerate it, basic granulated slag is associated with other binders, which act as hydraulic property activators. Moreover, the slag concrete is particularly suitable for making workpieces that require a high resistance to the disintegrating action of atmospheric agents, as well as in massive casting, due to its feature of having a low hydration heat. Moreover, slag proportionally increases the resistance to chemical attacks: it is particularly indicated for those workpieces that may come into contact with aggressive waters.

[0017] It should be noted that slag is treated as non hazardous industrial waste.

[0018] Therefore, the use of slag in prefabricated panels improves permeability and resistance to the attack of environmental chemical agents, imparting better duration features to the end product as compared to other

blends.

Exemplary embodiment of the panel according to the invention

[0019] In fig. 1, reference numeral 10 globally indicates an exemplary embodiment of the prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, object of the invention.

[0020] Said panel 10 comprises a plurality of prefabricated tiles 11 (fig. 2), assembled and steadily fixed to each other, in a geometrical arrangement according to lines and columns, so as to form a prefabricated wall element or the like 12, comprising a back base layer 12.1 substantially shaped as a parallelepiped sheet and a front facing layer 12.2 with a rusticated surface, having a plurality of pyramid cusps 13 with alternating orientation.

[0021] Two sturdy U-shaped metal section bars 14, parallel to each another, are respectively steadily fixed on opposite sides of panel 10 and are open outwards: they constitute support and connection elements for making a workpiece with prefabricated modular components.

[0022] Each prefabricated tile 11 (fig. 2) comprises, correspondingly and in a single body, two adhering structural layers, i.e.:

- a parallelepiped back base layer 11.1, made with a deep blending of concrete and slag in powder state and forming a barrier with a high sound insulating power, and
- a cusp front facing layer 11.2, made with a deep blending of concrete and slag in natural granulated state, so-called granular slag, and forming a barrier with a high sound absorbing power.

[0023] A metal armour 15, for example grid-like, is interposed between said back layer 11.1 and said front facing layer 11.2 of tile 11 for connecting said parts and structurally reinforcing the same tile.

[0024] An example of blends for making each of said two layers 11.1, 11.2 of said tile 11 and thus of panel 10 is provided hereinafter.

Sound insulating blends for making the back layer 11.1 constituting a sound insulating barrier (percentages by weight):

[0025] Foamed clay 5-40%, slag 5-60%, sand 5-40%, concrete 10-30%, added water 5-10%, additive CTC < 2%, gravel 5-50%. The slag is provided as ground powder.

Blends for making the front facing layer 11.2 constituting a sound absorbing barrier (percentages by weight):

[0026] Foamed clay 5-40%, slag 5-60%, sand 5-40%, concrete 10-30%, added water 5-10%, additive CTC < 2%. The slag is provided in natural grain shape, i.e. as so-called granular slag.

[0027] Indicative and exemplary dimensions of a prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, according to the invention.

[0028] The dimensions shall differ according to the different uses and to the features of the positioning place:

- minimum dimensions: length 50 cm , width 25 cm, thickness 15 cm;
- maximum dimensions: length 500 cm, width 150 cm, thickness 50 cm.

[0029] As is clear from the above, the panel according to the invention may also be made as a single body (rather than with a plurality of assembled tiles), comprising a back base layer constituting the sound insulating barrier and a front facing layer constituting the sound absorbing barrier.

[0030] The process for manufacturing the prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, according to the invention, comprises the following steps:

- in a suitably shaped formwork or mould, a first partial casting is made of a deep blending of concrete and slag in natural granulated state (granular slag), so as to form a front facing constituting a barrier with a high sound absorbing power;
- a second partial casting is then made for filling said formwork or mould, of a deep blending of concrete and powder slag, so as to form a back layer constituting a barrier with a high sound insulating power;
- the natural drying and hardening of the workpiece (8 to 12 hours, according to the operating conditions), or the drying and forced hardening in furnace (3 to 5 hours) are then carried out;
- and, finally, the operations for detaching the workpiece from said formwork or mould are carried out.

[0031] Advantageously, in said formwork or mould, a suitable metal armour, for example a grid, is positioned on said first casting for reinforcement and connection with said second casting.

[0032] As it appears from the above description, the present invention allows the objects described in the introduction of the present description to be achieved in a simple and advantageous manner.

Claims

1. Prefabricated sound insulating and sound absorbing panel (10) for building construction, roads, tunnels and the like, comprising at least two structural layers (11.1, 12.1; 11.2, 12.2), one of which at least contains blast furnace slag as sound insulating material, **char-**

acterized in that said panel (10) comprises:

- a back base layer (11.1; 12.1), made with a deep blending of concrete and slag in powder state and forming a barrier with a high sound insulating power, and
- a front facing layer (11.2; 12.2), made with a deep blending of concrete and slag in natural granulated state, so-called granular slag, and forming a barrier with a high sound absorbing power.

2. Panel according to claim 1, **characterized in that** said panel (10) comprises a plurality of prefabricated tiles (11), assembled and steadily fixed to one another so as to form a prefabricated wall element or the like (12), and **in that** each prefabricated tile (11) comprises two adhering structural layers:

- a back base layer (11.1), made with a deep blending of concrete and slag in powder state and forming a barrier with a high sound insulating power, and
- a front facing layer (11.2), made with a deep blending of concrete and slag in natural granulated state, so-called granular slag, and forming a barrier with a high sound absorbing power.

3. Panel according to claim 1 and/or 2, **characterized in that** said panel, respectively each prefabricated tile (11) of said panel, comprises a metal armour (15) for connecting said layers and for structural reinforcement.

4. Panel according to any one or more of the previous claims, **characterized in that** said front facing layer (11.2, 12.2) exhibits a rusticated surface (13).

5. Panel according to one or more of the previous claims, **characterized in that** said back layer (11.1, 12.1) is made with a deep blending of concrete and slag in powder state containing the following components (percentages by weight):

foamed clay 5-40%, slag 5-60%, sand 5-40%, concrete 10-30%,
added water 5-10%, additive CTC < 2%, gravel 5-50%, and
said front layer (11.2, 12.2) is made with a deep blending of concrete and slag in natural granulated state, so-called granular slag, containing the following components (percentages by weight):

- foamed clay 5-40%, slag 5-60%, sand 5-40%, concrete 10-30%, added water 5-10%, additive CTC < 2%.

6. Panel according to claim 1, **characterized in that** it comprises two sturdy substantially U-shaped metal section bars (14), parallel to one another, respectively steadily fixed on opposite sides of the same panel (10) and open outwards, which constitute support and connection elements for making a workpiece with prefabricated modular components.

7. Process for making the prefabricated sound insulating and sound absorbing panel for building construction, roads, tunnels and the like, according to one or more of the previous claims, **characterized in that** it comprises the following steps:

- in a suitably shaped formwork or mould, a first partial casting is made of a deep blending of concrete and slag in natural granulated state, so-called granular slag, so as to form a front facing constituting a barrier with a high sound absorbing power.
- a second partial casting is then made for filling said formwork or mould, of a deep blending of concrete and powder slag, so as to form a back layer constituting a barrier with a high sound insulating power;
- the natural drying is carried out with hardening of the workpiece (8 to 12 hours, according to the operating conditions), respectively the drying with forced hardening in furnace (3 to 5 hours);
- the operations for detaching the workpiece from said formwork or mould follow.

8. Process according to claim 7, **characterized in that** in said formwork or mould, a suitable metal armour is positioned on said first casting for reinforcement and connection with said second casting.

Patentansprüche

1. Vorgefertigte schallisolierende und schalldämpfende Platte (10) für Baukonstruktionen, Straßen, Tunnel und ähnliche, umfassend zumindest zwei Strukturschichten (11.1, 12.1; 11.2, 12.2), von denen eine zumindest Hochofenschlacke als akustisches Isoliermaterial enthält, **dadurch gekennzeichnet, dass** die besagte Platte (10) folgendes umfasst:

- eine rückseitige Grundschicht (11.1; 12.1), die mit einer intimen Mischung aus Zement und Schlacke im pulverförmigen Zustand hergestellt wird und eine Barriere mit großer Schallisolierfähigkeit bildet, und
- eine vorderseitige Wandflächenschicht (11.2; 12.2), die mit einer intimen Mischung aus Zement und Schlacke im natürlich-granulometrischen Zustand, sogenannter granulierter Schlacke, hergestellt wird und eine Barriere mit großer

Schalldämpffähigkeit bildet.

2. Platte nach Anspruch 1, **dadurch gekennzeichnet, dass** die besagte Platte (10) eine Vielzahl von vorgefertigten Verkleidungsbausteinen (11) umfasst, die zusammengesetzt und zueinander stabil befestigt sind, so dass sie ein vorgefertigtes Wandelement oder ähnliches (12) bilden, und dadurch dass jeder vorgefertigte Verkleidungsbaustein (11) zwei zusammenhängende Strukturschichten umfasst:

   - eine rückseitige Grundschicht (11.1), die mit einer intimen Mischung aus zement und Schlacke im pulverförmigen Zustand hergestellt wird und eine Barriere mit großer Schallisolierfähigkeit bildet, und
   - eine vorderseitige Wandflächenschicht (11.2), die mithilfe einer intimen Mischung aus Zement und Schlacke im natürlich-granulometrischen Zustand, sogenannter granulierter Schlacke, hergestellt wird und eine Barriere mit großer Schalldämpffähigkeit bildet.

3. Platte nach Anspruch 1 und/oder 2, **dadurch gekennzeichnet, dass** die besagte Platte, beziehungsweise jeder vorgefertigte Verkleidungsbaustein (11) der besagten Platte, eine Metallfassung (15) zur Vereinigung der besagten Schichten und zur strukturellen Verstärkung umfasst.

4. Platte nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die besagte vorderseitige Wandflächenschicht (11.2, 12.2) eine bossierte Oberfläche (13) aufweist.

5. Platte nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die besagte rückseitige Schicht (11.1, 12.1) mit einer intimen Mischung aus Zement und Schlacke im pulverförmigen Zustand hergestellt ist, welche die folgenden Bestandteile enthält (Massenanteil in Prozent):

   - Blähton 5-40%, Schlacke 5-60%, Sand 5-40%, Zement 10-30%, zugesetztes Wasser 5-10%, Zusatzstoff CTC < 2%, Erbse 5-50%, und die besagte vorderseitige Schicht (11.2, 12.2) mit einer intimen Mischung aus Zement und Schlacke im natürlich-granulometrischen zustand, sogenannter granulierter Schlacke, hergestellt ist, welche die folgenden Bestandteile enthält (Massenanteil in Prozent):
   - Blähton 5-40%, Schlacke 5-60%, Sand 5-40%, Zement 10-30%, zugesetztes Wasser 5-10%, Zusatzstoff CTC < 2%.

6. Platte nach Anspruch 1, **dadurch gekennzeichnet, dass** sie zwei robuste, metallische, im Wesentlichen U-förmige, zueinander parallele Profile (14) umfasst, die jeweils stabil auf den gegenüberliegenden Seitenflächen der Platte (10) selbst befestigt und nach außen hin geöffnet sind, welche die Trag- und Anschlusselemente für die Realisierung eines Erzeugnisses aus vorgefertigten modularen Bauteilen bilden.

7. Verfahren für die Herstellung der vorgefertigten schallisolierenden und schalldämpfenden Platte für Baukonstruktionen, Straßen, Tunnel und ähnliche, nach wenigstens einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es die folgenden Schritte umfasst:

   - in einer geeignet aufgebauten Schalung oder Form wird ein erster Teilguss einer intimen Mischung aus Zement und Schlacke im natürlich-granulometrischen Zustand, sogenannter granulierter Schlacke, ausgeführt, um so eine vorderseitige, eine Barriere mit hoher Schalldämpffähigkeit schaffende Wandfläche zu bilden;
   - anschließend wird, mit dem Ziel der Auffüllung der besagten Schalung oder Form, ein zweiter Teilguss einer intimen Mischung aus Zement und pulverförmiger Schlacke ausgeführt, um so eine rückseitige, eine Barriere mit hoher Schallisolierungsfähigkeit schaffende Schicht zu bilden;
   - es wird eine natürliche Trocknung mit Aufhärtung des Fertigteils (zwischen 8 und 12 Stunden, je nach Arbeitsbedingungen) ausgeführt, beziehungsweise die Trocknung mit Zwangsaushärtung im Ofen (zwischen 3 und 5 Stunden);
   - es folgen die Vorgänge in Bezug auf das Lösen des Fertigteils aus der besagten Schalung oder Form.

8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet, dass** in der besagten Schalung oder Form, auf dem besagten ersten Guss eine geeignete, gegenüber dem besagten zweiten Guss verstärkende und vereinende, Metallfassung platziert wird.

Revendications

1. Panneau (10) préfabriqué isolant acoustique et absorbant acoustique pour bâtiments, routes, tunnels et similaires, comprenant au moins deux couches structurelles (11.1, 12.1; 11.2, 12.2) dont au moins l'une comporte du laitier de haut fourneau en tant que matériau d'isolation acoustique, **caractérisé en ce que** ledit panneau (10) comprend :

   - une couche de base dorsale (11.1; 12.1), réalisée avec un mélange intime de ciment et de laitier à l'état de poudre et formant une barrière

à haut pouvoir d'isolation acoustique, et
- une couche de parement frontale (11.2; 12.2), réalisée avec un mélange intime de ciment et de laitier à l'état granulométrique naturel, dénommé laitier granulé, et formant une barrière à haut pouvoir d'absorption acoustique.

2. Panneau selon la revendication 1, **caractérisé en ce que** ledit panneau (10) comprend une pluralité de carreaux préfabriqués (11) assemblés et fixés entres eux de manière stable afin de former un élément préfabriqué de mur ou similaires (12), et **en ce que** chaque carreau préfabriqué (11) comprend deux couches structurelles adhérentes :

- une couche de base dorsale (11.1), réalisée avec un mélange intime de ciment et de laitier à l'état de poudre et formant une barrière à haut pouvoir d'isolation acoustique, et
- une couche de parement frontale (11.2), réalisée avec un mélange intime de ciment et de laitier à l'état granulométrique naturel, dénommé laitier granulé, et formant une barrière à haut pouvoir d'absorption acoustique.

3. Panneau selon la revendication 1 et/ou 2, **caractérisé en ce que** ledit panneau, respectivement chaque carreau préfabriqué (11) dudit panneau, comprend une armature métallique (15) de jonction desdites couches et de renforcement structurel.

4. Panneau selon l'une ou plus des revendications précédentes, **caractérisé en ce que** ladite couche de parement frontale (11.2, 12.2) présente une surface bosselée (13).

5. Panneau selon l'une ou plus des revendications précédentes, **caractérisé en ce que** ladite couche dorsale (11,1, 12.1) est réalisée avec un mélange intime de ciment et de laitier à l'état de poudre comportant les composants suivants (pourcentages en poids) :

- argile expansée 5-40%, laitier 5-60%, sable 5-40%, ciment 10-30%, eau ajoutée 5-10%, additif CTC < 2%, gravillon 5-50%, et ladite couche frontale (11.2, 12.2) est réalisée avec un mélange intime de ciment et de laitier à l'état granulométrique naturel, dénommé laitier granulé, comportant les composants suivants (pourcentages en poids) :
- argile expansée 5-40%, laitier 5-60%, sable 5-40%, ciment 10-30%, eau ajoutée 5-10%, additif CTC < 2%.

6. Panneau selon la revendication 1, **caractérisé en ce qu'**il comprend deux robustes profilés métalliques sensiblement en U (14), parallèles entre eux, respectivement fixés de manière stable sur les côtés opposés du même panneau (10) et ouverts vers l'extérieur, qui constituent des éléments de support et de connexion pour la réalisation d'un ouvrage à composants modulaires préfabriqués.

7. Procédé de production du panneau préfabriqué isolant acoustique et absorbant acoustique pour bâtiments, routes, tunnels et similaires, selon l'une ou plus des revendications précédentes, **caractérisé en ce qu'**il comprend les étapes suivantes :

- dans un coffrage ou moule convenablement conformé on effectue une première coulée partielle d'un mélange intime de ciment et de laitier à l'état granulométrique naturel, dénommé laitier granulé, afin de former un parement frontal constituant une barrière à haut pouvoir d'absorption acoustique ;
- on effectue ensuite une deuxième coulée partielle, jusqu'à remplissage dudit coffrage ou moule, d'un mélange intime de ciment et de laitier en poudre afin de former une couche dorsale constituant une barrière à haut pouvoir d'isolation acoustique ;
- on effectue un séchage naturel avec maturation de la pièce (8 à 12 heures selon les conditions de fonctionnement), respectivement le séchage avec maturation forcée en fourneau (3 à 5 heures);
- suivis par les opérations de détachement de la pièce dudit coffrage ou moule.

8. Procédé selon la revendication 7, **caractérisé en ce que**, dans ledit coffrage ou moule, on place sur ladite première coulée une armature métallique de renforcement et de jonction adaptée par rapport à ladite deuxième coulée.

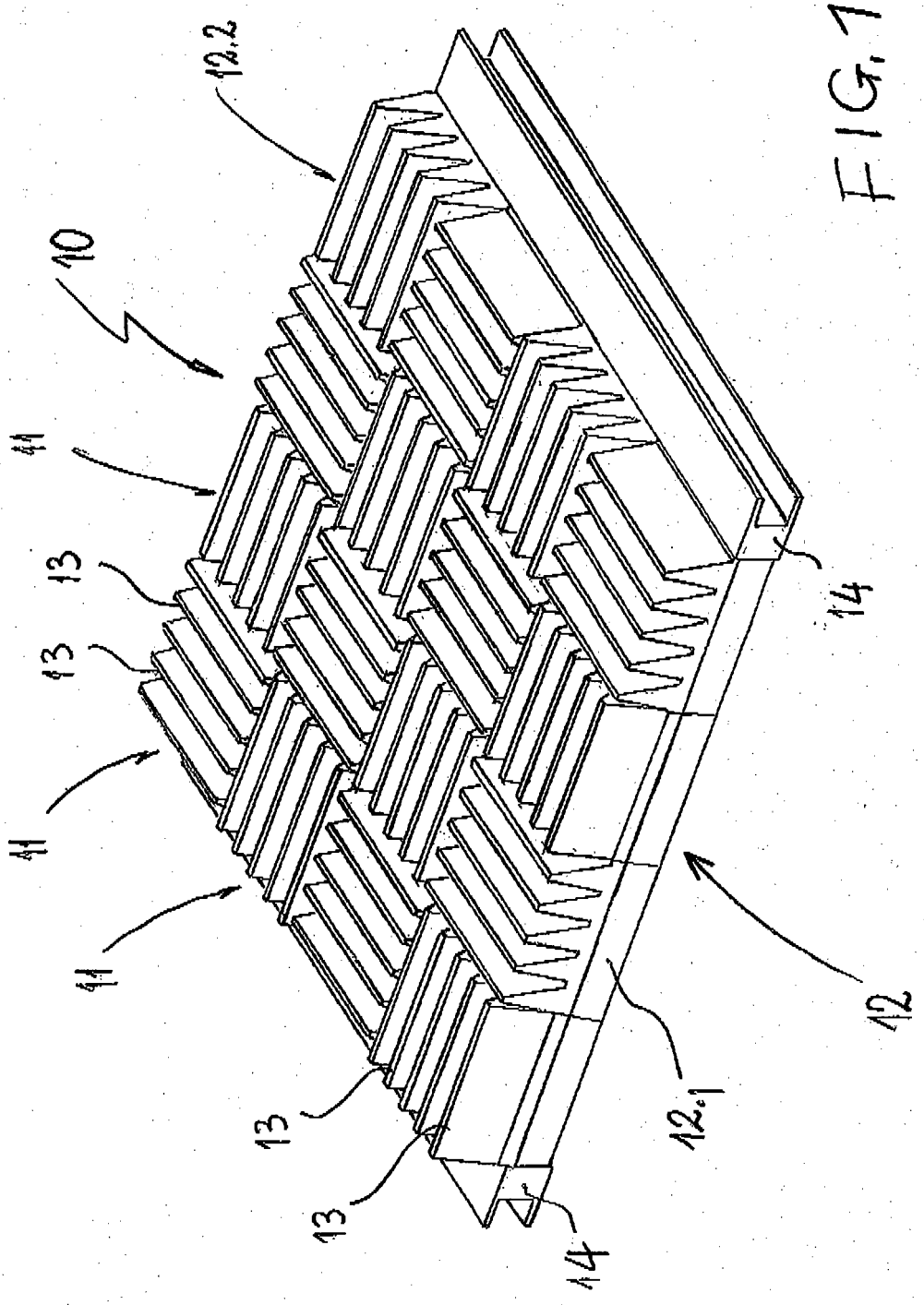

FIG. 1

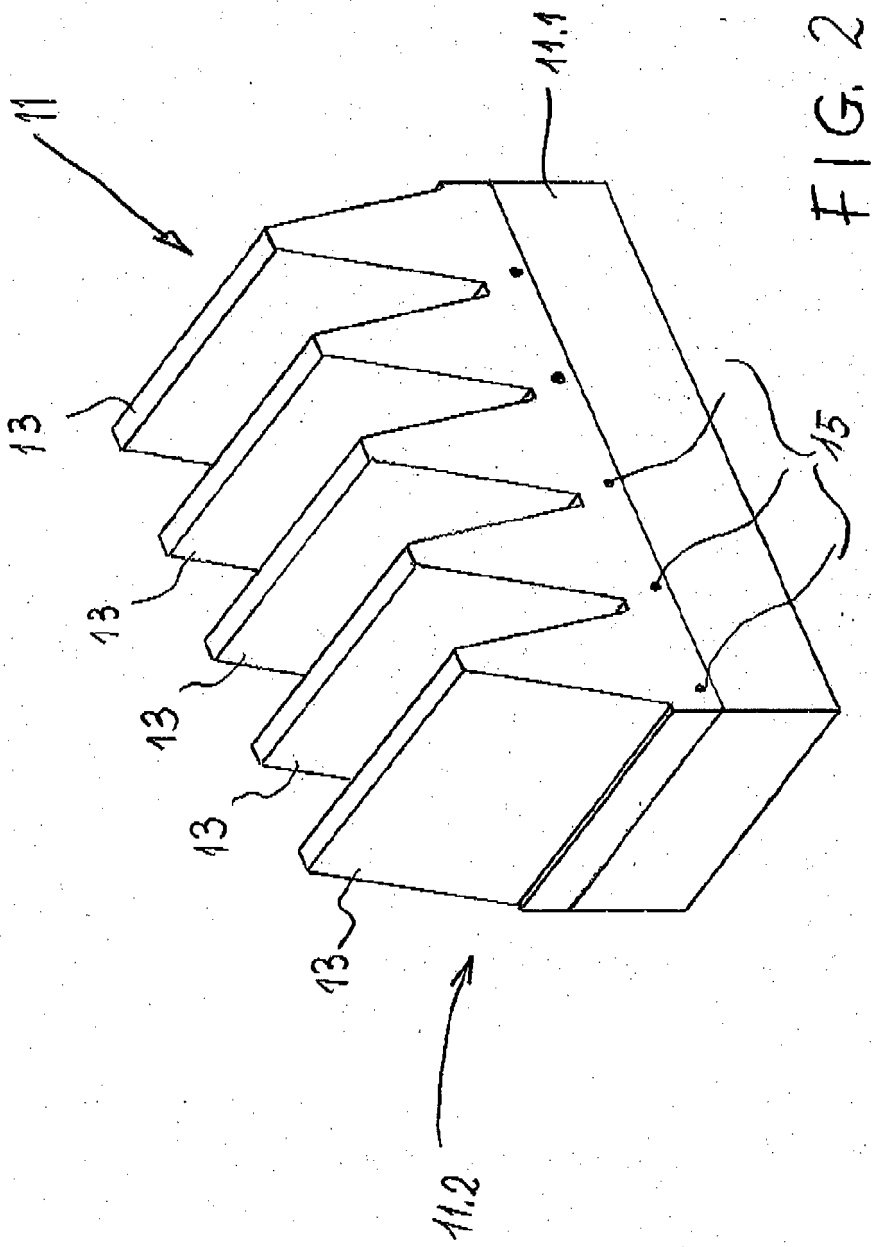

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 101634176 A **[0002] [0013]**
- US 20100078260 A **[0003]**