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(54) Ring furnace including flue walls with built-in expansion joints

(57) The invention relates to a ring furnace having a plurality of hollow partitions (3, 3') acting as flue walls and defining baking pits for stacking carbonaceous articles therein. So as to allow thermal expansion of the bricks (110) during use, while preserving the transverse imperviousness of the hollow partitions, at least one built-in expansion joint is arranged in at least one of said hollow partitions by providing at least one gap (111, 112) between specified bricks in each said lateral wall and by arranging sealing bricks (1111, 1112, 1121, 1122) within said hollow partition so as to overlap said gap and thereby seal the same.

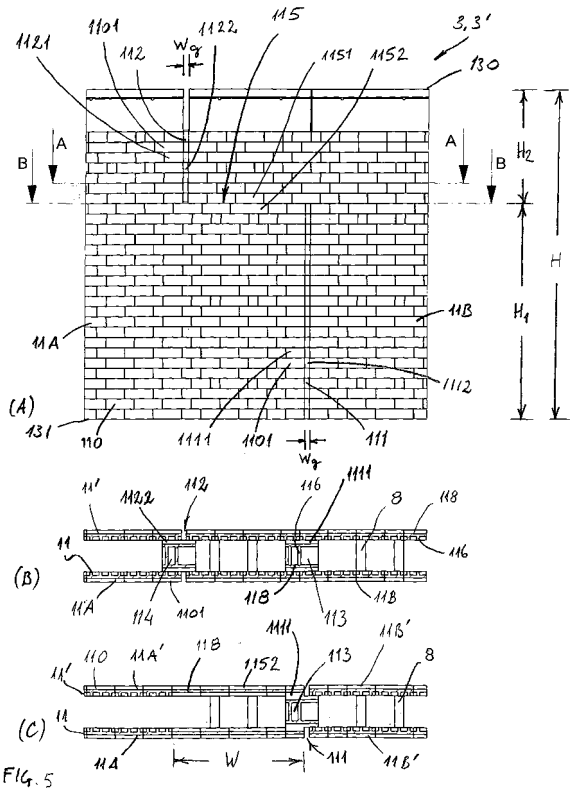

FIG. 5

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Description

Field of the Invention

[0001] The invention relates to ring furnaces for baking carbonaceous articles, especially open type ring furnaces. The invention relates more specifically to the internal structure of ring furnaces.

Background Art

[0002] Open type ring furnaces are well known. British application GB 2,129,918 and U.S. Patents Nos. 5,683,631 and 6,339,729 describe such ring furnaces.

[0003] Open type ring furnaces comprise series of baking pits that are delimited by hollow partitions, often called flue walls, and transverse walls. The partitions and walls are made of refractory bricks, such as those described in International Applications Nos. WO 95/22666 and WO 97/35150.

[0004] The baking pits are designed to receive green carbonaceous articles and packing material therein during the baking operations. The hollow partitions are intended for the circulation of heating flue and cooling gas during the baking operations. The transverse walls partition the furnace into a plurality of separate firing sections.

[0005] Groups of successive sections are simultaneously utilized to make up a baking sequence for a batch of carbonaceous articles. For that purpose, heating equipment is installed at a specific location of groups of sections while exhaust equipment is installed downstream of the heating means and blowing equipment is installed upstream of the same. After completion of a firing operation, all pieces of equipment are shifted downstream by a specified number of sections.

[0006] The increase in temperature of the sections during the firing cycles of the carbonaceous blocks causes the hollow partitions and transverse walls to expand, which can damage them or deform them or even deform the casing of the furnace. In order to avoid these difficulties, it is known to leave certain bricks free to slide over one another and to create a small space, called an "expansion joint", between certain bricks and between the hollow partitions and the transverse walls. These joints absorb the expansions of the partitions.

[0007] The expansion joints at the junction between the hollow partitions and the transversal walls comprise indentations in the transversal walls in which the hollow partitions are inserted with both longitudinal and transversal clearance. The clearance enables the hollow partitions to move longitudinally within the indentations when they thermally expand or contract during a baking process. These joints are filled with a compressible refractory material in order to make them impervious and prevent the packing material contained in the pits to pass through them during the firing of the carbonaceous blocks.

[0008] However, such indented expansion joints require a permanent supply of compressible material and the handling of the same on industrial plants. Moreover, the imperviousness of such indented expansion joints most often deteriorate over time, so that packing material may enter the junction between the hollow partitions and the transversal walls and thereby hinder the expansion movement of the hollow partitions.

[0009] The applicants addressed the issue of finding alternative means to avoid the drawbacks of the prior art.

Description of the Invention

[0010] A first object of the invention is a ring furnace having a longitudinal axis X-X' and comprising a first elongated bay and a second elongated bay, each bay being parallel to said axis and including a casing, a plurality of hollow partitions arranged within said casing of each bay so as to be parallel to said axis, a first end transverse wall located at a first end of each bay, a second end transverse wall located at a second end of each bay and a plurality of intermediate transverse walls located between said first and second ends, said transverse walls being arranged so as to be perpendicular to said axis, said hollow partitions and transverse walls defining baking pits within said bays for stacking carbonaceous articles therein, said hollow partitions having lateral walls comprising bricks, wherein, so as to allow thermal expansion of said bricks while preserving the transverse imperviousness of said hollow partitions, at least one of said hollow partitions includes at least one gap between specified bricks in each said lateral wall and sealing bricks arranged within said hollow partition so as to overlap said gap and thereby seal the same.

[0011] Said gap and sealing bricks form a sealed, built-in expansion joint that makes it possible to allow large thermal expansion of the hollow partitions while maintaining the cohesion and imperviousness of said partitions.

[0012] The built-in expansion joints make it possible to avoid the need for expansion joints between the hollow partitions and the transverse walls. In other words, the junctions between the hollow partitions and the transverse walls may be made tight, for example by providing indentations so dimensioned that the hollow partitions can snugly fit therein without clearance and compressible material between the same.

[0013] Said ring furnace is particularly intended for the baking of carbonaceous anodes designed for use in electrolysis

cells intended for the production of aluminium through the Hall-Héroult process.

[0014] The invention is described in detail below with reference to the appended figures wherein:

Figure 1 illustrates a perspective view of an open ring furnace according to prior art.

Figure 2 illustrates a perspective view, partially exploded, of an open ring furnace according to prior art.

Figure 3 illustrates a perspective view of typical wall bricks.

Figures 4 and 5 illustrate partial views of a hollow partition of an open ring furnace according to a preferred embodiment of the invention.

As illustrated in Figures 1 and 2, an open type ring furnace (1) usually comprises two parallel bays (10, 10') that are typically symmetrically arranged with respect to a longitudinal axis X-X' (X-axis). Said bays are generally circumscribed by a casing (15, 15'), which is typically made of concrete. Said bays have a length Lf that is typically between 50 and 100 metres and that may now reach and possibly exceed 150 meters.

Said bays (10, 10') include external lateral partitions (15A, 15A', 15B, 15B') and a plurality of inner partitions (3, 3', 4, 4') that form series of baking pits (2, 2') having an elongated shape parallel to said longitudinal axis. Said baking pits (2, 2') have a length Lp in the longitudinal direction and a width Wp in the transverse direction. Said length Lp is typically comprised between 3 and 6 meters.

Each of said bays (10, 10') includes a first end transverse wall (41, 41') at one end and a second end transverse wall (42, 42') at an opposite end and a plurality of intermediate transverse walls (43, 43') evenly distributed between said end transverse walls (41, 41', 42, 42'). Said transverse walls (41, 41', 42, 42', 43, 43') partition said bays (10, 10') into series of distinct sections (So, S1, S2, S3,...).

Said baking pits (2, 2') are delimited by hollow partitions (3, 3'), said transverse walls (41, 41', 42, 42', 43, 43') - more particularly the pillars (5) thereof - and a floor (16). Said hollow partitions (3, 3') and transverse walls (41, 41', 42, 42', 43, 43') form the substantially vertical sides of said baking pits while said floor (16) forms a bottom that is substantially horizontal. Refractory lining (18) is usually provided within said casing (15, 15') at the bottom and on the sides thereof.

Each bay (10, 10') comprises alternately, in a transversal direction (Y axis), baking pits (2, 2') and hollow partitions (3, 3'), usually called flue walls, that are parallel to said longitudinal direction (X axis).

During baking operations, a gaseous flow containing air, heating gas, vapours given off by the carbonaceous articles or combustion gases (or, most often, a mixture of them) circulates, in the longitudinal direction of the furnace (X axis), in said hollow partitions (3, 3'). Said gaseous flow is blown upstream of active zones of the furnace and is sucked downstream thereof. The heat produced by the combustion of the gases is transmitted to said carbonaceous articles (30) contained in the baking pits (2, 2'), which leads to their firing.

The hollow partitions of one bay are connected to the hollow partitions of the neighbouring bay by a first by-bass conduit (13) at one end of said bays and by a second by-pass conduit (14) at the opposite end of said bays, so as to allow the circulation of flue gas from one bay to the other one when a baking sequence overlaps said two bays.

Figure 2 shows a typical stack of carbonaceous articles (30) in a baking pit (2, 2') surrounded by packing material (34) for a baking operation. Said packing material (34) protects said articles (30) and avoids their burning during a baking operation.

Said packing material (34) is typically added by pouring the same into the baking pits (2, 2') containing said stacking arrangement (31) so as to cover most of the top and sides thereof. Typically, the packing material contained in a pit is removed by suction before specified baked articles are removed from said furnace.

Said hollow partitions (3, 3') have a width Wc and, as illustrated in Figure 2, include a first lateral wall (11) and a second lateral wall (11') that are generally separated by tie bricks (8) and baffles (9). The ends of the hollow partitions (3, 3') are usually inserted in indentations (6) provided in said transverse walls (41, 41', 42, 42', 43, 43'). Said indentations (6) are fitted with one or more apertures (7) in order to allow the gases circulating in said hollow partitions (3, 3') to pass from one section to the next. Said hollow partitions (3, 3') typically also include a headwall (12) at each end, said headwall comprising one or more apertures (7A) to allow said gases to pass from one section to the next. Said hollow partitions (3, 3') are also fitted with means of access (19) called "peepholes" which are used to introduce heating means (such as heating ramps), blowing means or exhaust means. For example, said exhaust means typically includes suctions pipes (23) connected to an exhaust ramp (21) and connected to a main conduit (22) that typically runs alongside the furnace.

Said inner partitions (3, 3', 4, 4') usually include bricks and may be so assembled that the bricks are directly in contact with each other ("dry" assembly) and/or so that an embedding material, such as grout or mortar, is placed between the bricks.

In particular, said hollow partitions (3, 3') include a plurality of refractory bricks (110) and, preferably, further include means to allow thermal expansion of said bricks while limiting the deformation of said hollow partitions (3, 3'), such as their bowing. Said means typically comprise interlocking means, which typically include recesses on one surface of said bricks and projections on an opposite surface of said bricks. Said projections of a brick are generally so

dimensioned that they can fit in corresponding recesses of an adjacent brick so as to provide interlocking action.

Figure 3 illustrates possible embodiments of such bricks (110) wherein an upper surface (123) includes a longitudinal projection (118) having a first width A1 and transverse projections (116) each having a second width A2, and a lower surface (122) includes a longitudinal recess (119) having a third width A3 and transverse recesses (117) each having a fourth width A4. In the embodiment illustrated in Figure 3(A) said brick (110) includes half-crossing transverse projections (116). In the embodiment illustrated in Figure 3(B) said brick (110) includes full-crossing transverse projections (116). In these examples, surface 122 is a lower surface, surface 123 is an upper surface and surfaces 120 and 121 are vertical surfaces intended to correspond to the vertical surfaces of the lateral walls (11, 11') of hollow partitions (3, 3'). Surfaces 122 and 123 may alternatively be upper and lower surfaces, respectively.

Said recesses (117, 119) are typically selected from the group consisting of grooves. Said projections (116, 118) are typically selected from the group consisting of tongues.

According to the invention, at least one of said hollow partitions (3, 3') that have lateral walls (11, 11') includes one or more built-in expansion joints. Said built-in expansion joint includes at least one gap between specified bricks in each said lateral wall (11, 11') and sealing bricks within said hollow partition that are arranged so as to overlap said gap and thereby seal the same, i.e., so as to make it substantially impervious to gas and packing material. In other words, said built-in expansion joint are formed by sealed expansion gaps between specified bricks. Said gap enables thermal expansion of said lateral walls (11, 11') while said sealing bricks limit the flow of gas and packing material (34) between the inside of said hollow partitions (3, 3') and said pits (2, 2').

The width Wg of said at least one gap is preferably comprised between 10 and 75 mm, and typically comprised between 40 and 60 mm.

Figures 4 and 5 illustrate a possible embodiment of such an alternative in which a hollow partition includes one or more vertical gaps (111, 112) and pillars (113, 114) that form sealed, built-in expansion joints. Said pillars (113, 114) are formed by said sealing bricks (1111, 1112, 1121, 1122) and positioned so as to overlap said gaps (111, 112), thereby sealing the same from inside said at least one partition.

Figure 4(A) shows a perspective view of a part of such a hollow partition. Figure 4(B) shows a vertical, longitudinal section view of the same. Figure 5(A) shows a side view of a part of the same. Figure 5(B) is a horizontal cross sectional view of the same along plane A-A. Figure 5(C) is a horizontal cross sectional view of the same along plane B-B.

[0015] Said pillars (113, 114) are typically made of at least one vertical stack of bricks that preferably includes transverse bricks (1111, 1121) that fit into the lateral walls (11, 11') of said hollow partitions (3, 3') so as to stabilize the same. Said pillars (113, 114) typically also include inner bricks (1112, 1122) that are adjacent said lateral walls (11, 11'), and more specifically adjoin wall bricks (1101). At least part of the bricks (1111, 1112, 1121, 1122) that form said pillars (113, 114) overlap said gaps (111, 112) and, preferably, snugly fit between said lateral walls (11, 11'), so as to seal said gaps (111, 112) while enabling relative longitudinal displacements between said bricks and part of said lateral walls.

[0016] In this example a hollow partition has a top (130), a bottom (131) and a height H and includes at least one first vertical gap (111) running from said bottom (131) to a specified height H1, at least one second vertical gap (112) longitudinally shifted, having a length H2 and running from height H1 to said top (130), a sliding plane (115) located at height H1, between said first and second gaps, at the interface between a first horizontal row of sliding bricks (1151) and a second horizontal row of sliding bricks (1152), at least one first vertical pillar (113) running from said bottom (131) to a specified height H1, and at least one second vertical pillar (114) longitudinally shifted, having a length H2 and running from height H1 to said top (130).

[0017] Said sliding plane (115) that joins said gaps (111, 112) has width W and allows relative longitudinal displacement of a first part (11A, 11A') of said lateral walls (11, 11') that lie on one side of said gaps (111, 112) and a second part (11B, 11B') of said lateral walls (11, 11') that lie on the other side thereof longitudinally. Said width W is typically comprised between 800 mm and 1500 mm. Said sliding bricks (1151, 1152) advantageously comprise at least one longitudinal projection and/or at least one longitudinal recess on an upper or lower surface of said sliding bricks, such as the tongues (118) illustrated in Figure 5(C), to allow relative longitudinal displacements of said sliding bricks while avoiding relative transverse displacements of the same, in order to stabilize their position transversally while allowing longitudinal sliding as a result of thermal expansion.

[0018] In this embodiment, all bricks may be assembled using mortar or grout, except within said gaps (111, 112) and sliding plane (115).

[0019] The shift between said vertical pillars (113, 114) creates a passage for flue gases and air within the partition while allowing thermal expansion.

[0020] Preferably, each hollow partition (3, 3') includes at least one built-in expansion joint. In other words, each of said hollow partitions (3, 3') preferably includes said at least one gap (111, 112) between specified bricks in each said lateral wall (11, 11') and said sealing bricks (1111, 1112, 1121, 1122) arranged within said hollow partition so as to overlap said gap (111, 112) and thereby seal the same.

[0021] Said hollow partitions (3, 3') may further include tie bricks (8) and/or baffles (9) to direct the flow of flue gas.

[0022] Said hollow partitions (3, 3') typically further include upper blocks or caps (19A) that bridge said lateral walls (11, 11').

List of reference numerals

[0023]

1	Ring furnace
2, 2'	Baking pit
3, 3'	Hollow partition (flue wall)
4, 4'	Transverse wall
5	Pillar
6	Indentation
7	Aperture in transverse wall
7A	Aperture in headwall
8	Tie brick
9	Baffle
10, 10'	Bays
11, 11'	Lateral wall of a hollow partition
11A, 11A', 11B, 11B'	Part of lateral wall
12	Headwall
13, 14	By-pass conduit
15, 15'	Casing
15A, 15A', 15B, 15B'	External lateral partition of casing
16	Floor of a baking pit
18	Refractory lining
19	Peephole
19A	Upper blocks or caps of hollow partition
21	Exhaust ramp
22	Main conduit
23	Suction pipe
30	Carbonaceous article
31	Stacking arrangement
34	Packing material
41, 41'	First end transverse wall
42, 42'	Second end transverse wall
43, 43'	Intermediate transverse wall
110	Refractory bricks
111	Gap
112	Gap
113	Pillar
114	Pillar
115	Sliding plane
116	Transverse projection
117	Transverse recess
118	Longitudinal projection
119	Longitudinal recess
120	Lateral surface
121	Lateral surface
122	Lower surface
123	Upper surface
130	Top of hollow partition
131	Bottom of hollow partition
1101	Wall brick
1111	Transverse sealing brick
1112	Inner sealing brick
1121	Transverse sealing brick

1122	Inner sealing brick
1151	Upper sliding brick
1152	Lower sliding brick

Claims

1. Ring furnace (1) having a longitudinal axis X-X' and comprising a first elongated bay (10) and a second elongated bay (10'), each bay being parallel to said axis and including a casing (15, 15'), a plurality of hollow partitions (3, 3') arranged within said casing of each bay so as to be parallel to said axis, a first end transverse wall (41, 41') located at a first end of each bay (10, 10'), a second end transverse wall (42, 42') located at a second end of each bay (10, 10') and a plurality of intermediate transverse walls (43, 43') located between said first and second ends, said transverse walls (41, 41', 42, 42', 43, 43') being arranged so as to be perpendicular to said axis, said hollow partitions and transverse walls defining baking pits (2, 2') within said bays (10, 10') for stacking carbonaceous articles (30) therein, said hollow partitions (3, 3') having lateral walls (11, 11') comprising bricks, wherein, so as to allow thermal expansion of said bricks while preserving the transverse imperviousness of said hollow partitions, at least one of said hollow partitions (3, 3') includes at least one gap (111, 112) between specified bricks in each said lateral wall (11, 11') and sealing bricks (1111, 1112, 1121, 1122) arranged within said hollow partition so as to overlap said gap (111, 112) and thereby seal the same.

2. Ring furnace (1) according to Claim 1, wherein said at least one gap (111, 112) is vertical and wherein said sealing bricks (1111, 1112, 1121, 1122) form at least one pillar (113, 114) that is positioned so as to overlap said gap (111, 112), thereby sealing said gap (111, 112) from inside said at least one hollow partition.

3. Ring furnace (1) according to Claim 2, wherein said pillars (113, 114) are made of at least one vertical stack of bricks that includes transverse bricks (1111, 1121) that fit into said lateral walls (11, 11') of said at least one hollow partition so as to stabilize the same.

4. Ring furnace (1) according to any one of Claims 2 or 3, wherein said at least one hollow partition has a top (130), a bottom (131) and a height H and includes at least one first vertical gap (111) running from said bottom (131) to a specified height H1, at least one second vertical gap (112) longitudinally shifted, having a length H2 and running from height H1 to said top (130), a sliding plane (115) located at height H1, between said first and second gaps, at the interface between a first horizontal row of sliding bricks (1151) and a second horizontal row of sliding bricks (1152), at least one first vertical pillar (113) running from said bottom (131) to a specified height H1, and at least one second vertical pillar (114) longitudinally shifted, having a length H2 and running from height H1 to said top (130).

5. Ring furnace (1) according to Claim 4, wherein said sliding plane (115) allows relative longitudinal displacement of a first part (11A, 11A') of said lateral walls (11, 11') that lie on one side of said gaps (111, 112) and a second part (11B, 11B') of said lateral walls (11, 11') that lie on the other side thereof longitudinally.

6. Ring furnace (1) according to any one of Claims 4 and 5, wherein said sliding plane (115) has a width W that is comprised between 800 mm and 1500 mm.

7. Ring furnace (1) according to any one of Claims 4 to 6, wherein said sliding bricks (1151, 1152) comprise at least one longitudinal projection and/or at least one longitudinal recess on an upper or lower surface thereof to allow relative longitudinal displacements of said sliding bricks while avoiding relative transverse displacements of the same, in order to stabilize their position transversally while allowing longitudinal sliding as a result of thermal expansion.

8. Ring furnace (1) according to any one of Claims 1 to 7, wherein said at least one gap (111, 112) has a width Wg that is comprised between 10 and 75 mm.

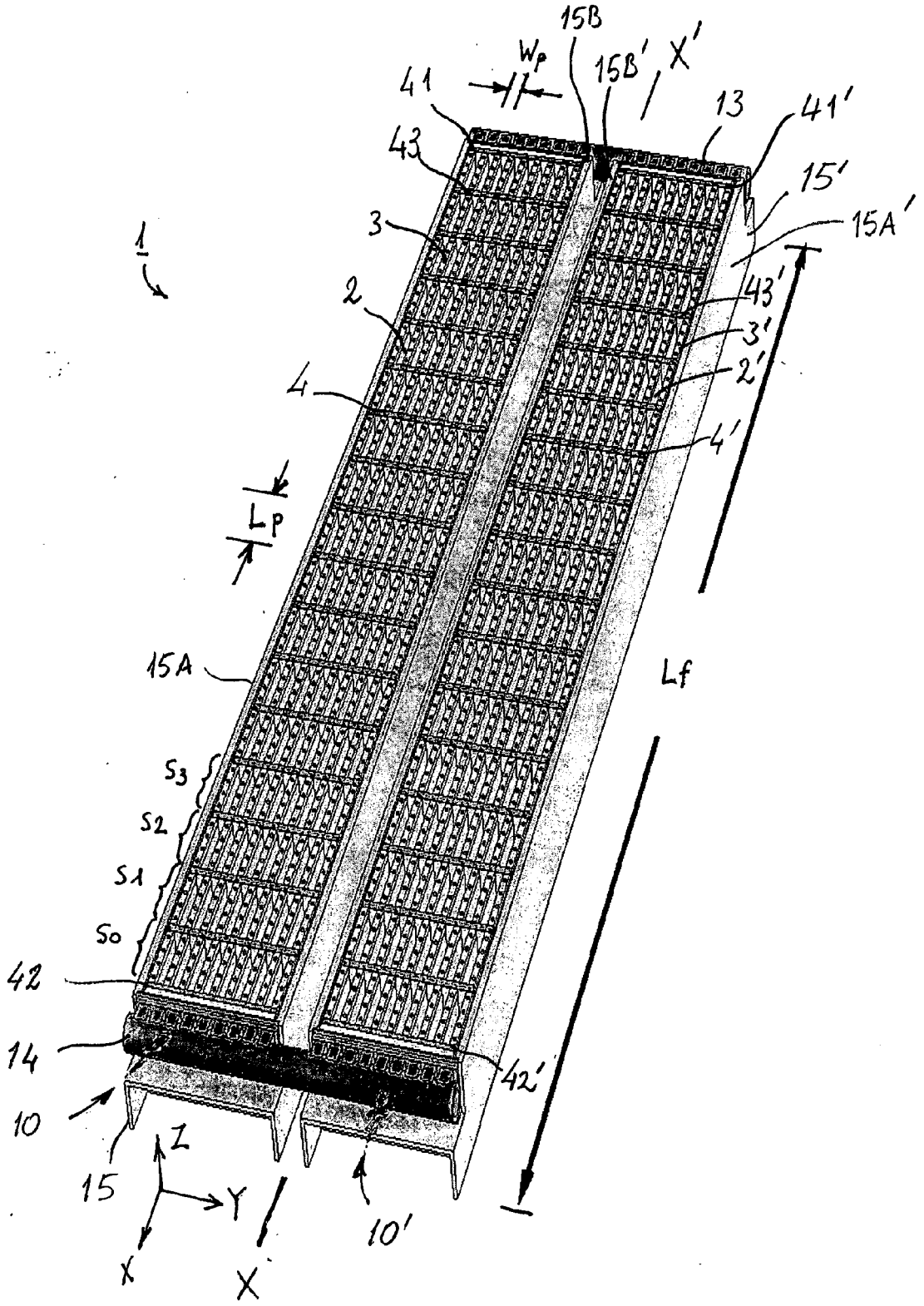
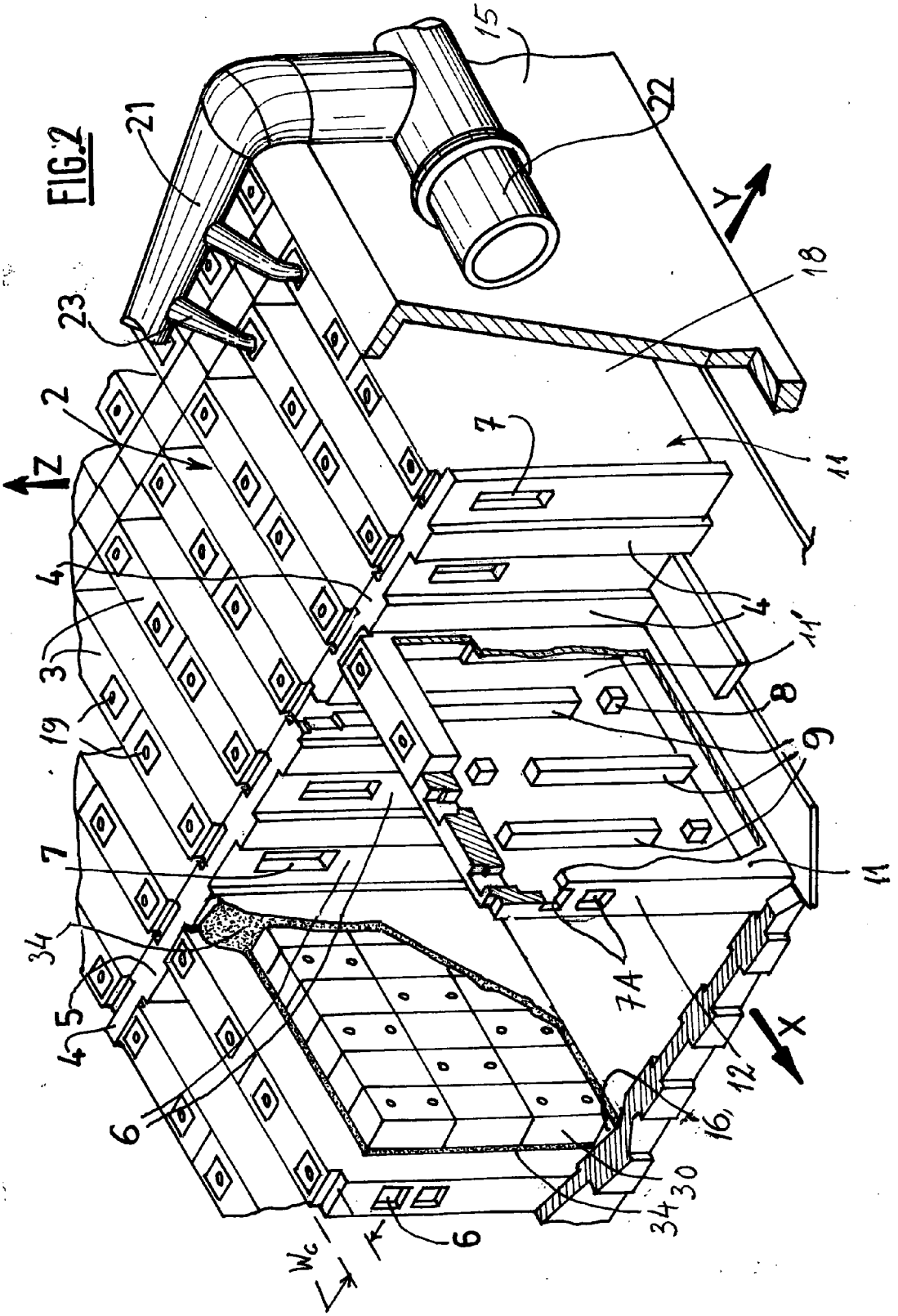
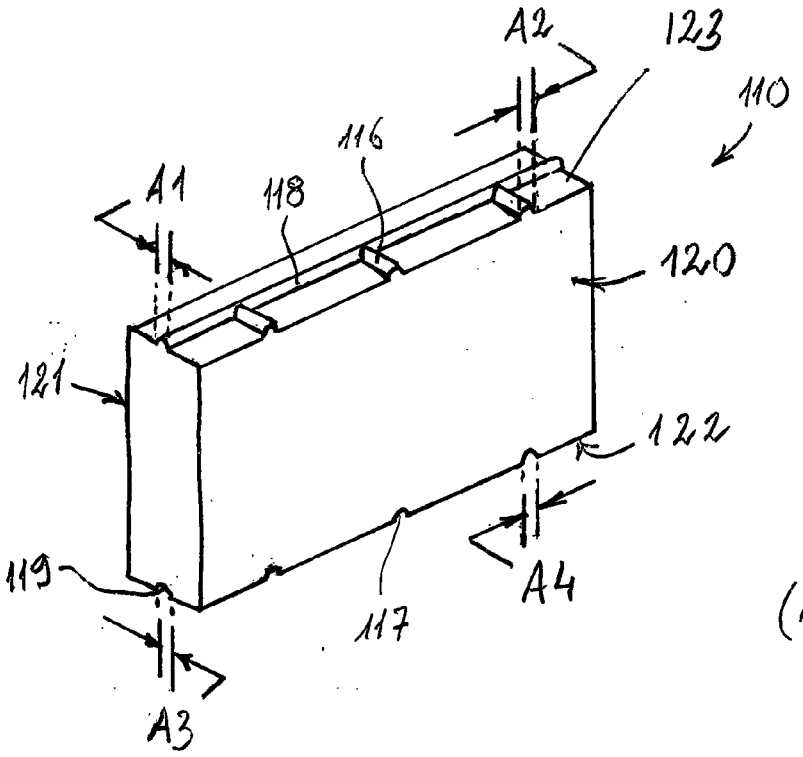

15B
Wp
15B'
X'
41
13
41'
43
15'
15A'
1
3
2
43'
3'
2'
4
4'
Lp
15A
Lf
S3
S2
S1
So
42
14
42'
10
15
Z
Y
X
10'
X

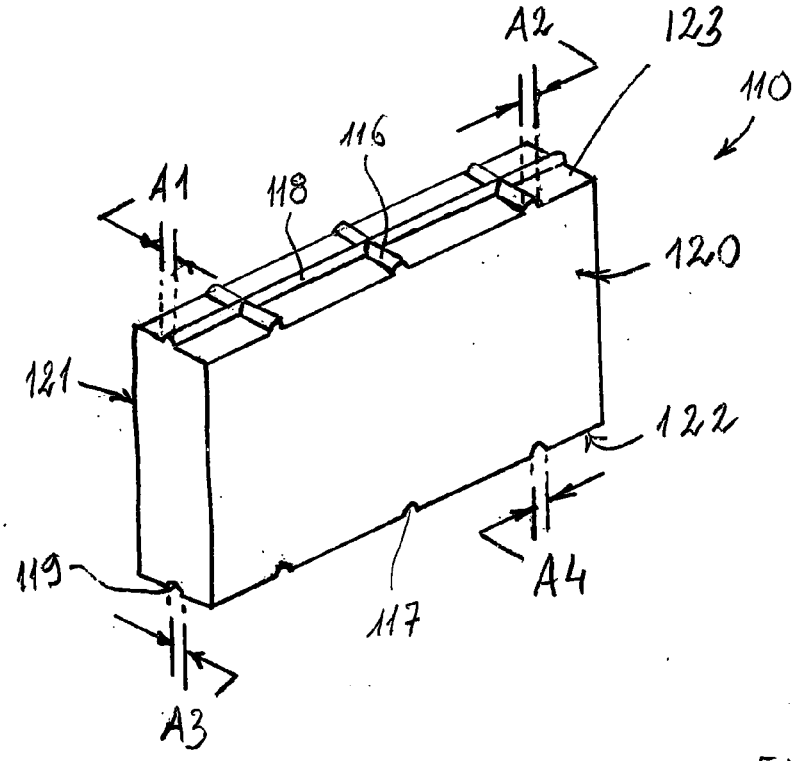
FIG. 1

FIG.2




A2
123
110
116
A1
118
120
121
122
119
117
A4
A3

(A)


A2
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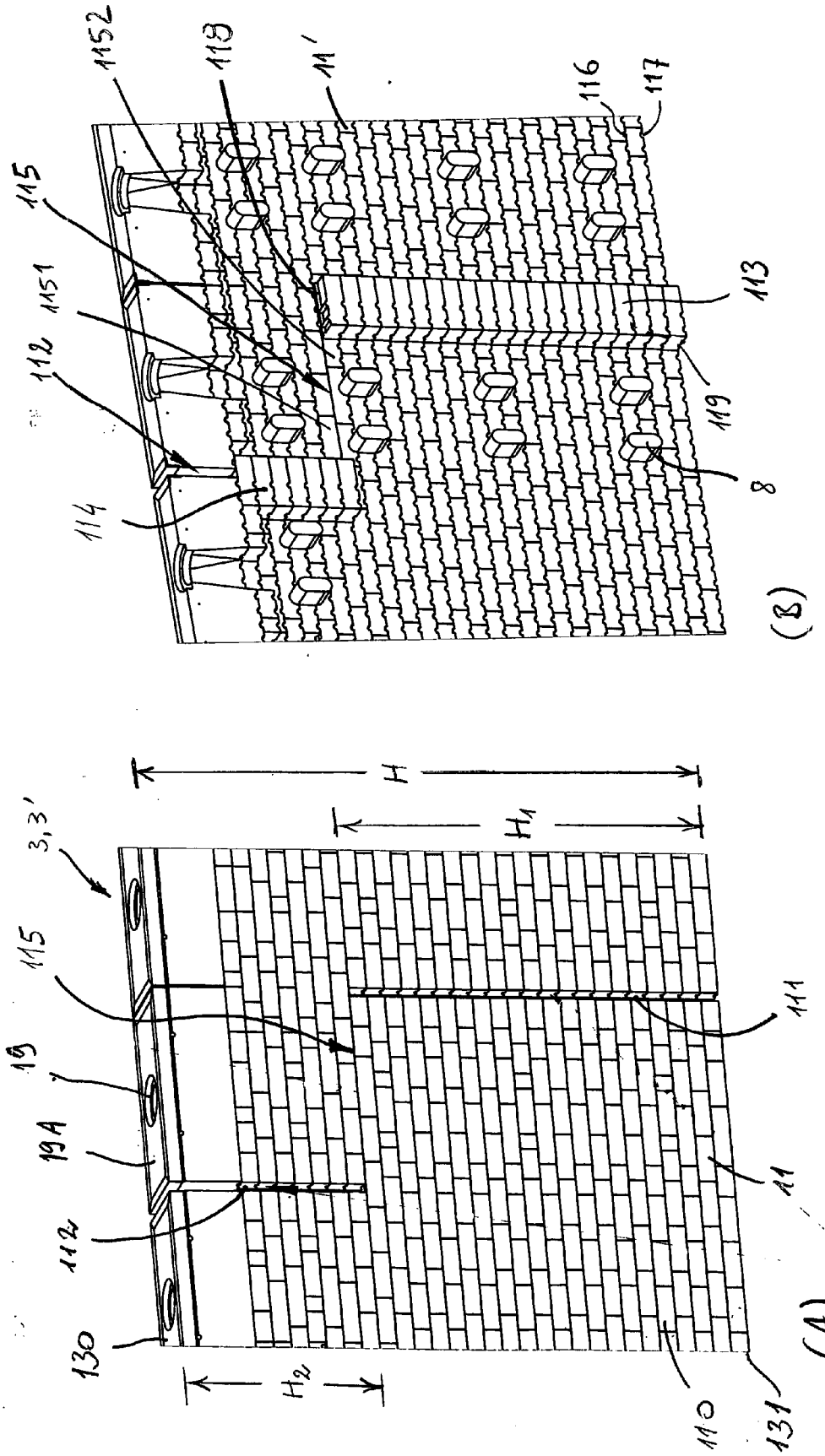
A1
118
120
121
122
119
117
A4
A3

(B)

FIG. 3


1152
119
11'
116
117
115
1151
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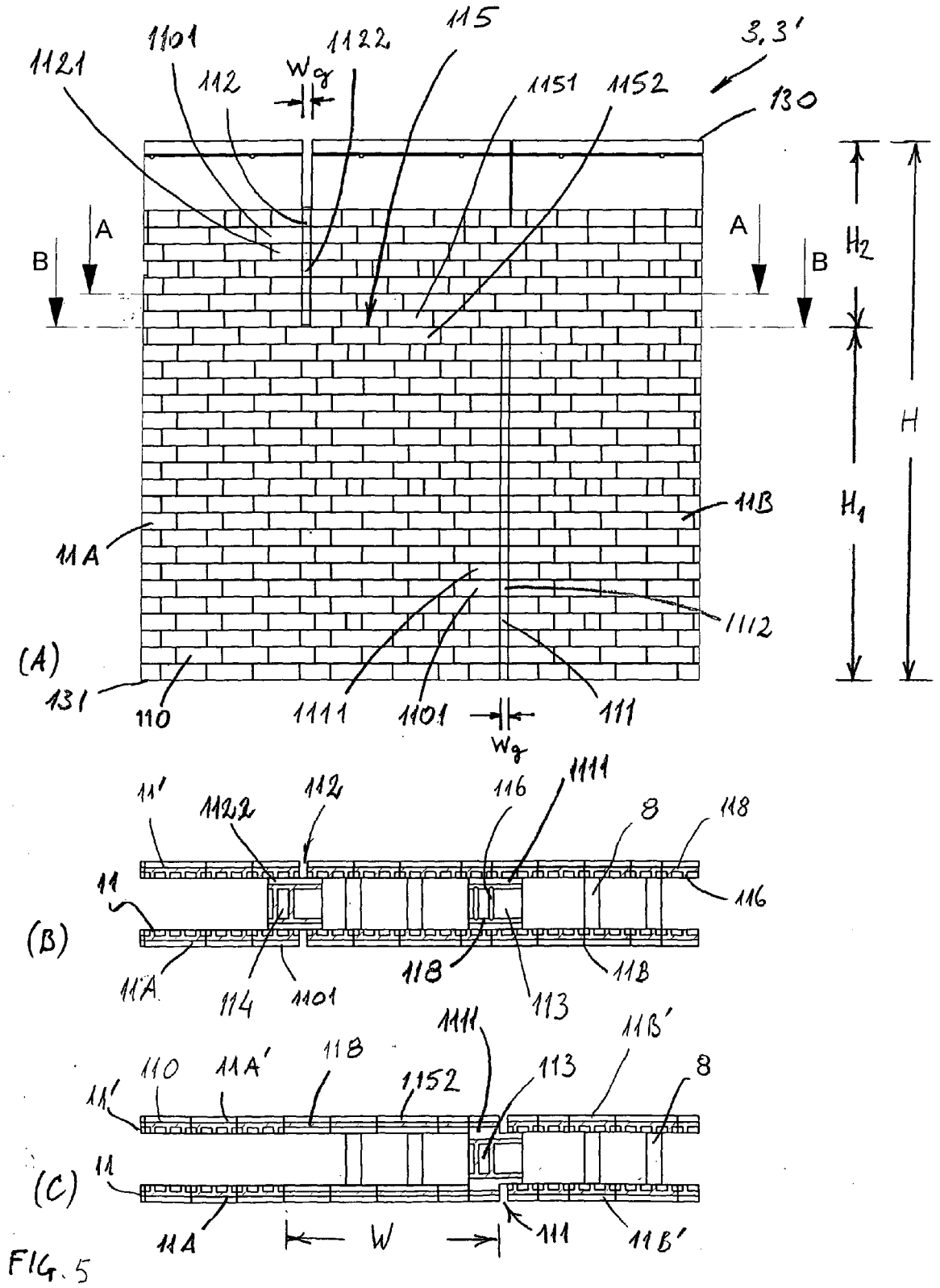
112
119
114
8
(B)
H
H1
3,3'
115
111
19
19'
19A
11
112
130
H2
110
131
(A)

FIG 4


1121
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112
Wg
1122
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A
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H2
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11A
1112
(A)
131
110
1111
1101
Wg
111
11'
1122
112
116
1111
8
118
11
116
(B)
11A
114
1101
118
113
11B
1111
11B'
110
11A'
11B
1152
113
8
11'
11
(C)
11A
W
111
11B'

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 35 6066

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			TECHNICAL FIELDS SEARCHED (IPC)
			F27B F27D C10B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 September 2007	Peis, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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24-09-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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