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

(11) EP 1 385 920 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
17.08.2005 Bulletin 2005/33

(21) Application number: **02720681.2**

(22) Date of filing: **24.04.2002**

(51) Int Cl.[7]: **C10B 29/02**

(86) International application number:
PCT/NO2002/000156

(87) International publication number:
WO 2002/088276 (07.11.2002 Gazette 2002/45)

(54) A WALL STRUCTURE FOR USE IN A FURNACE

WANDKONSTRUKTION ZUR VERWENDUNG IN EINEM OFEN

STRUCTURE DE PAROI DESTINEE A ETRE UTILISEE DANS UN FOUR

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **26.04.2001 NO 20012044**

(43) Date of publication of application:
04.02.2004 Bulletin 2004/06

(73) Proprietor: **NORSK HYDRO ASA**
0240 Oslo (NO)

(72) Inventors:
- **RUUD, Anders**
  N-6885 Ardalstangen (NO)
- **LINGA, Hogne**
  N-6885 Ardalstangen (NO)
- **FARDAL, Arnstein**
  N-6600 Sunndalsora (NO)
- **FLUGE, Arnt, Johnny**
  N-6600 Sunndalsora (NO)

(74) Representative: **Bleukx, Lucas Lodewijk M.**
Bleukx Consultancy BVBA
Rijksweg 237
3650 Dilsen-Stokkem (BE)

(56) References cited:
WO-A1-92/22780
CH-A- 258 544
US-A- 5 704 781

EP 1 385 920 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention concerns a wall structure for use in a furnace for calcination of carbon blocks as it is mentioned in the preamble of claim 1. Such a wall structure is known from the WO92/227780 A1.

[0002] Furnaces for calcination of carbon blocks to be used in the production of aluminium in accordance with the Hall-Héroult process may be designed with several sections arranged in two parallel rows. Such furnaces have a combustion cycle which is moved in relation to the sections as the carbon material is calcinated. The sections are mutually and successively linked by ducts which conduct hot combustion gas or flue gas through the furnace structure. Each section can be divided into several smaller pits by means of flue walls or cassette walls. These flue walls are provided with several flue gas ducts, through which hot gas is conducted in order to be able to transfer heat efficiently to objects placed in the sections so that the calcination process becomes as homogeneous as possible. One problem with such furnaces, in which the flue walls may extend for several metres both vertically and horizontally, is that the walls lose their parallelism over time as a consequence of heating/cooling cycles with large temperature differences. In the worst cases, bowing and creep can cause problems running the furnace in a satisfactory manner. This is on account of leakage and burn-off or problems inserting/removing objects as a consequence of large geometrical deviations in the pits.

[0003] CH 258544 shows a furnace in which a partition wall may comprise flue gas ducts (fig. 3). In this solution, an attempt is made to absorb longitudinal changes in the partition wall as a consequence of thermal heating/cooling in vertical joints between each brick, while the wall ends are fixed in place. One problem which will arise over time when using this principle for expansion/contraction is that particles from material placed in the furnace may be deposited in the joints and prevent the intended expansion fully or partially. If the wall has a certain clearance between where it is fixed and the rest of the structure of the furnace, this clearance will gradually be used up as the partition wall is extended permanently as a consequence of the stated mechanism. Over time, therefore, a structure of this type may bow and lose its parallelism. Further problems which may arise are that bricks may be crushed fully or partially if the necessary expansion is not permitted after a given number of thermal cycles. A subsequent collapse of brick work may thus occur, which will give rise to expensive repair work and put the furnace fully or partially out of operation for a period of time.

[0004] It is the object of the present invention to provide a wall structure with which the expansion or contraction of the wall structure in its longitudinal direction as a consequence of thermal cycles will be compensated while bricks are mutually locked to each other, whereby a wall structure is provided which is very stable over repeated temperature cycles and with which the costs related to restoration of brick work and possible stoppages of the furnace can thus be reduced considerably.

[0005] This object is obtained by a wall structure as it is defined in claim 1.

[0006] Specific embodiments of the wall structure according to the present invention are subject-matter of claims 2 to 7.

[0007] The present invention will be described in further detail in the following by means of examples and figures, where:

Fig. 1 show, in sections from above, details concerning the fixing of one end of a partition wall in relation to adjacent brickwork,
Fig. 2 shows, in sections from above, two parallel partition walls fixed at their ends to adjacent brickwork,
Fig. 3 shows a detail of the fixing of the ends of the partition walls,
Fig. 4 shows a detail of the end of the partition wall,
Fig. 5 shows another detail of the end of the partition wall,
Fig. 6 shows a detail of the structure of the partition wall.

[0008] Figure 1 shows, in sections from above, brickwork 1, which may be a head wall in a furnace which may be built up from a row of individual bricks. The brickwork shown in the figure is adapted for the fixing of partition walls 3', 3", 3"', 3"" (only four are partially shown in the figure). The connection 2 between the partition wall 3' and the brickwork 1 is shown in an enlarged section in the lower part of the figure. This section shows an end brick 4 in the partition wall 3', a wedge brick 6 and an anchor brick 5 which constitutes part of the brickwork 1 and is permanently fixed to it. The wedge brick 6 may expediently have a rectangular cross-section and have side surfaces 10, 10' which interact with the respective surfaces 8, 9 and 8', 9' of the end brick and anchor brick. The anchor brick 5 and end brick 4 are mutually movable and expansion of the partition wall of which the end brick is a part is permitted via the expansion joint 7 between the end surface 14 of the wedge brick and the surface 11 of the end brick. Contraction, which may occur in the wall structure, can be compensated for in that the end brick 4 is permitted to move away from the anchor brick 5 while the connection via the wedge brick 6 is maintained. In an alternative embodiment, the connection may consist of only two elements, i.e. without the wedge brick, in that a shape equivalent to the wedge brick is made as an integral part of either the anchor brick or end brick. The size of the expansion joint 7 is adjusted according to experience, depending on the brick material, operating conditions with the application in question or other conditions. The same will apply to the longitudinal contact in the connection 2 with regard to contraction of the wall structure.

[0009] It is expedient for the interacting surfaces in the connection 2 to run along the full vertical extent of the partition wall, i.e. all courses of bricks in the partition wall and equivalent courses in the brickwork are designed in the way shown in the figure. One advantage of such a design is that variations in the length of the wall structure, including in its vertical direction, can be absorbed in the connection 2.

[0010] In the example shown in the figure, the adjacent surfaces 13, 12 on the anchor brick 5 and end brick 4 respectively are designed with chamfor so that the surfaces create a V-shape. The aim of such a V-shape is that particle material which may lie against the partition wall and which consequently may be pressed in against the connection can be drained out of this area in connection with an expansion (extension) of the partition wall. It is also advantageous for the surfaces to have a V-shape during emptying/cleaning of the section. The angle between the surfaces may expediently be 30° or more. The size of this angle will, among other things, depend on the material to be drained away and the surface pressure for which the surfaces are designed. Moreover, the connection 2 will comprise surfaces which form a seal to the extent that no problems will arise with the penetration of material into the connection during a contraction-related movement of the end brick 4.

[0011] Figure 2 shows, in sections from above, two parallel partition walls 114, 115 which are fixed at their ends to adjacent brickwork 101, 102. In this embodiment, the connections are designed so that the anchor bricks 103, 104, 105, 106 are shaped in such a way that the wedge brick forms an integral part of the anchor brick. The anchor bricks thus interact directly with the adjacent end bricks 107, 108, 109, 110.

[0012] The figure shows that the pattern for bricks in the course in partition wall 114 is different from that in partition wall 115 with regard to the design of the bricks. In the first partition wall, end brick 107 has one flue gas duct 111, while end brick 108 in partition wall 115 has two flue gas ducts 112, 113. An equivalent arrangement is shown at the other ends of the partition walls. Moreover, brick 116 with flue gas ducts 118, 119 in partition wall 114 has the same design as brick 117 with flue gas ducts 120, 121 in partition wall 115, but the horizontal position in the respective walls is different.

[0013] By laying alternating courses equivalent to that shown in the section of partition wall 114 and that shown in the section of partition wall 115 over each other when building up the partition walls, the bricks will be anchored to each other via courses of bricks above and below each other by means of interacting contact elements, among other things by means of the design of the flue gas ducts. This will be illustrated in further detail in figures 4-6.

[0014] Figure 3 shows details of the fixing of the ends of the partition walls, more precisely an expedient design of an anchor brick. The upper part of the figure shows, in perspective, the lower side of a brick 150, while the lower part of the figure shows, in perspective, the upper side of an equivalent brick 150'. The bricks' external shapes correspond to that shown in earlier figures, but figure 3 also shows interacting elements which are designed to ensure mutual retention between the different courses of anchor bricks. In the example shown, anchor brick 150 is provided with rotationally symmetrical recesses 151 which interact with the rotationally symmetrical bosses 151' in anchor brick 150'. It is expedient for the interacting elements to have a semispherical shape or rounded cone shape. However, other geometrical shapes may also be used. As the figure also shows, the bricks' protruding parts 153, 153' (equivalent to the integral wedge brick in 6 in figure 1) are provided with interacting elements 152, 152'. In the embodiment shown, the element 152 consists of a rotationally symmetrical recess, while the equivalent element 152' consists of a rotationally symmetrical protrusion. It is expedient for these elements to have a mainly cylindrical shape. A structure of anchor bricks as shown here will produce stable brickwork in which forces which may arise locally in, for example, one or more bricks, can be distributed partially to bricks in courses above and below. This will be particularly favourable for the protruding parts of the bricks, where, for example, forces which arise on the protruding part 153 on brick 150 can be distributed to the underlying brick 150' via interacting elements 152, 152' and, in equivalent fashion, to any brick above (not shown).

[0015] Figure 4 shows a brick equivalent to brick 107 as shown in figure 2. The upper part of the figure shows the brick from above. The lower part of the figure shows the brick in a section from the side. The figure shows the flue gas duct 111, which, at its top, has a raised end 200 and, at its lower part, has a recess 201. The raised end 200 is adapted to an equivalent recess in a brick designed to be placed on brick 107, while the recess 201 is designed to fit on a raised part of an underlying brick (not shown). The raised ends and recesses will contribute to the flue gas duct having a sealed connection between the courses and they will contribute to a good mutual anchoring of the bricks. Moreover, the brick 107 may be provided with transverse tongue 202, 202' at its top and equivalent transverse recesses 203 at its bottom for further stabilisation of the brick.

[0016] Figure 5 shows a brick equivalent to brick 108 in figure 2. The upper part of the figure shows the brick from above and the lower part of the figure shows the brick in a section from the side. The figure shows flue gas ducts 112, 113, which, at their top, have raised ends 250, 251 and, at their lower parts, have recesses 252, 253. The raised ends 250, 251 are adapted to equivalent recesses in one or two bricks designed to be placed on brick 108, while the recesses 252, 253 are designed to fit on raised parts of one or two underlying bricks (not shown). The raised ends and recesses will contribute to the flue gas ducts having a sealed connection between

the courses and they will contribute to a good mutual anchoring of the bricks. As in the previous figure, the brick 108 may be provided with transverse tongues 254, 254' at its top and equivalent transverse recesses 255 at its bottom for further stabilisation of the brick.

[0017] Figure 6 shows a brick equivalent to brick 116 in figure 2. The upper part of the figure shows the brick from above and the lower part of the figure shows the brick in a section from the side. The figure shows flue gas ducts 118, 119, which, at their top, have raised ends 300, 301 and, at their lower parts, have recesses 302, 303. The raised ends 300, 301 are adapted to equivalent recesses in one or two bricks designed to be placed on brick 116, while the recesses 302, 303 are designed to fit on raised parts of one or two underlying bricks (not shown). The raised ends and recesses will contribute to the flue gas ducts having a sealed connection between the courses and they will contribute to a good mutual anchoring of the bricks. However, it may be necessary to use mortar or a sealing compound for further stabilisation of the connections between the bricks.

[0018] Although the examples show partition walls with flue gas ducts, equivalent advantages and principles to those in the present invention may also be exploited for wall structures without ducts running through them, where the structure is exposed to large thermal loads in another way. This may, for example, be the case for wall structures installed inside a furnace chamber in order to divide the chamber.

[0019] In the embodiments shown, the contact elements are designed so that protrusions are arranged on the top of the bricks, while recesses are arranged on the bottom of the bricks. However, it would also lie within the framework of the present invention if the protrusions were arranged on the bottom and the recesses on the top or possibly if a combination of these were used.

[0020] In accordance with the present invention, the movements which arise in the wall structure are mainly absorbed at at least one end, which may be fixed against other brickwork in a furnace. A certain relative movement must also be permitted between the wall structure and its underlying structure, for example a fixed floor structure.

Claims

1. A wall structure for use in a furnace for calcination of carbon blocks, where the wall structure is exposed to cyclic thermal loads, the wall structure consisting of bricks of refractory material in several courses and comprising internal flue gas ducts, wherein the wall structure is able to compensate for longitudinal changes as a consequence of the cyclic thermal loads, which longitudinal changes are absorbed by a connection (2) at at least one end of the wall structure,
   characterised in that
   the bricks in adjacent courses are offset in relation to each other and at least two of them (107, 108, 116, 117) comprise contact elements (200, 250, 251, 300, 301) interacting with complementary contact elements (201, 252, 253, 302, 303) of the bricks in the adjacent course, wherein the contact elements (200, 250, 251, 300, 301; 201, 252, 253, 302, 303) being raised ends and recesses of the ends of the flue gas ducts respectively arranged in the bricks (107, 108, 116, 117).

2. A wall structure in accordance with claim 1,
   characterised in that
   the connection (2) comprises at least one end brick (4) and one anchor brick (5) arranged for mutual movement in the longitudinal direction of the wall structure.

3. A wall structure in accordance with claim 2,
   characterised in that
   the connection (2) is also designed for movement between the end brick (4) and the anchor brick (5) in the vertical direction.

4. A wall structure in accordance with claim 2 or 3,
   characterised in that
   the end brick (4) and anchor brick (5) are connected to each other by means of a wedge brick (6).

5. A wall structure in accordance with claim 4,
   characterised in that
   the end brick (4), anchor brick (5) and the wedge brick (6) are provided with interacting connecting surfaces which are mainly parallel to the longitudinal direction of the wall structure.

6. A wall structure in accordance with claim 2,
   characterised in that
   the anchor brick (5) is permanently connected to brickwork, such as a head wall, and is also provided with contact elements at its top and bottom.

7. A wall structure in accordance with claim 2,
   characterised in that
   the anchor brick (5) and end brick (4) are designed with surfaces (13, 12) which mutually form a V-shape for drainage of any material away from the connection (2).

Patentansprüche

1. Wandkonstruktion zur Verwendung in einem Ofen zur Kalzinierung von Kohlenstoffblöcken, wo die Wandkonstruktion zyklischen thermischen Belastungen ausgesetzt ist, wobei die Wandkonstruktion aus Ziegelsteinen oder feuerfestem Material in mehreren Schichten besteht und interne Rauch-

gaskanäle umfasst, wobei die Wandkonstruktion in der Lage ist, Veränderungen in länglicher Richtung als eine Folge der zyklischen thermischen Belastungen auszugleichen, wobei die Veränderungen in länglicher Richtung durch eine Verbindung (2) zumindest an einem Ende der Wandkonstruktion aufgenommen werden,
dadurch gekennzeichnet, dass
die Ziegelsteine in benachbarten Schichten im Verhältnis zueinander versetzt sind, und mindestens zwei von ihnen (107, 108, 116, 117) Kontaktelemente (200, 250, 251, 300, 301) umfassen, die mit zusammen passenden Kontaktelementen (201, 252, 253, 302, 303) von Ziegelsteinen in der benachbarten Schicht zusammenarbeiten, wobei die Kontaktelemente (200, 250, 251, 300, 301; 201, 252, 253, 302, 300) aus erhabenen Enden und Vertiefungen an den Enden der Rauchgaskanäle bestehen, die jeweils in den Ziegelsteinen (107, 108, 116 117) angeordnet sind.

2. Wandkonstruktion nach Anspruch 1, **dadurch gekennzeichnet, dass** die Verbindung (2) mindestens einen Abschlussziegel (4) und einen Ankerziegel (5) umfasst, die für eine gegenseitige Bewegung in länglicher Richtung der Wandkonstruktion angeordnet sind.

3. Wandkonstruktion nach Anspruch 2, **dadurch gekennzeichnet, dass** die Verbindung (2) außerdem zur Bewegung in der vertikalen Richtung zwischen dem Abschlussziegel (4) und dem Ankerziegel (5) ausgelegt ist.

4. Wandkonstruktion nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** der Abschlussziegel (4) und der Ankerziegel (5) mittels eines Keilziegels (6) miteinander verbunden sind.

5. Wandkonstruktion nach Anspruch 4, **dadurch gekennzeichnet, dass** an dem Abschlussziegel (4), dem Ankerziegel (5) und dem Keilziegel (6) zusammenwirkende Verbindungsoberflächen zur Verfügung gestellt sind, welche im Wesentlichen parallel zu der länglichen Richtung der Wandkonstruktion verlaufen.

6. Wandkonstruktion nach Anspruch 2, **dadurch gekennzeichnet, dass** der Ankerziegel (5) ständig mit Mauerwerk, wie beispielsweise einer Stirnwand, verbunden ist, und an seiner Oberseite und Bodenseite außerdem Kontaktelemente zur Verfügung gestellt sind.

7. Wandkonstruktion nach Anspruch 2, **dadurch gekennzeichnet, dass** der Ankerziegel (5) und der Abschlussziegel (4) mit Oberflächen (13, 12) ausgestaltet sind, welche im Verhältnis zueinander eine V-Form zur Ableitung von jeglichem Material aus der Verbindung (2) heraus bilden.

Revendications

1. Structure formant mur à utiliser dans un four de calcination de blocs de carbone, où la structure formant mur est exposée à des charges thermiques cycliques, la structure formant mur consistant en briques de matériau réfractaire en plusieurs assises et contenant des conduits internes de gaz de combustion, la structure formant mur étant capable de compenser des changements longitudinaux consécutifs aux charges thermiques cycliques, lesquels changements longitudinaux sont absorbés par une articulation (2) à au moins une extrémité de la structure formant mur,
caractérisée en ce que
les briques d'assises adjacentes sont décalées les unes par rapport aux autres et au moins deux d'entre elles (107, 108, 116, 117) comportent des éléments de contact (200, 250, 251, 300, 301) interagissant avec des éléments de contact complémentaires (201, 252, 253, 302, 303) des briques de l'assise adjacente, les éléments de contact (200, 250, 251, 300, 301 ; 201, 252, 253, 302, 303) étant des extrémités bombées et des cavités des extrémités des conduits de gaz de combustion agencées respectivement dans les briques (107, 108, 116, 117).

2. Structure formant mur selon la revendication 1,
caractérisée en ce que
l'articulation (2) se compose au moins d'une brique d'about (4) et d'une brique d'ancrage (5) agencées à mouvement mutuel dans le sens longitudinal de la structure formant mur.

3. Structure formant mur selon la revendication 2,
caractérisée en ce que
l'articulation (2) est aussi conçue pour se mouvoir entre la brique d'about (4) et la brique d'ancrage (5) dans le sens vertical.

4. Structure formant mur selon la revendication 2 ou 3,
caractérisée en ce que
la brique d'about (4) et la brique d'ancrage (5) sont articulées l'une avec l'autre au moyen d'une brique formant coin (6).

5. Structure formant mur selon la revendication 4,
caractérisée en ce que
la brique d'about (4), la brique d'ancrage (5) et la brique formant coin (6) sont pourvues de surfaces d'articulation interagissantes qui sont sensiblement parallèles au sens longitudinal de la structure formant mur.

6. Structure formant mur selon la revendication 2, **caractérisée en ce que** la brique d'ancrage (5) est reliée en permanence à la maçonnerie, telle qu'un mur frontal, et est aussi pourvue d'éléments de contact sur son sommet et sur sa base.

7. Structure formant mur selon la revendication 2, **caractérisée en ce que** la brique d'ancrage (5) et la brique d'about (4) sont conçues avec des surfaces (13, 12) qui forment mutuellement une figure en V pour drainer tout matériau hors de l'articulation (2).

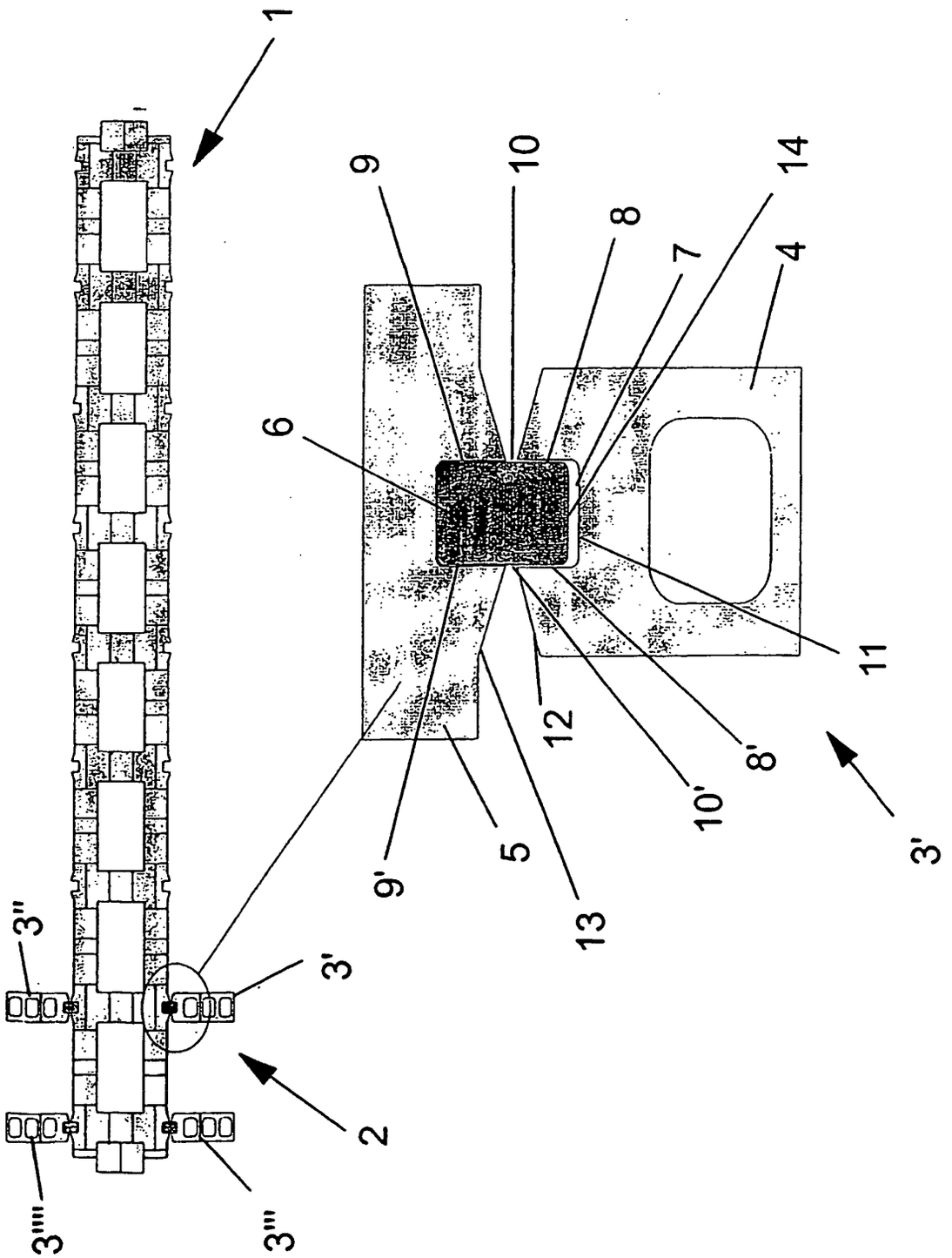


Fig. 1

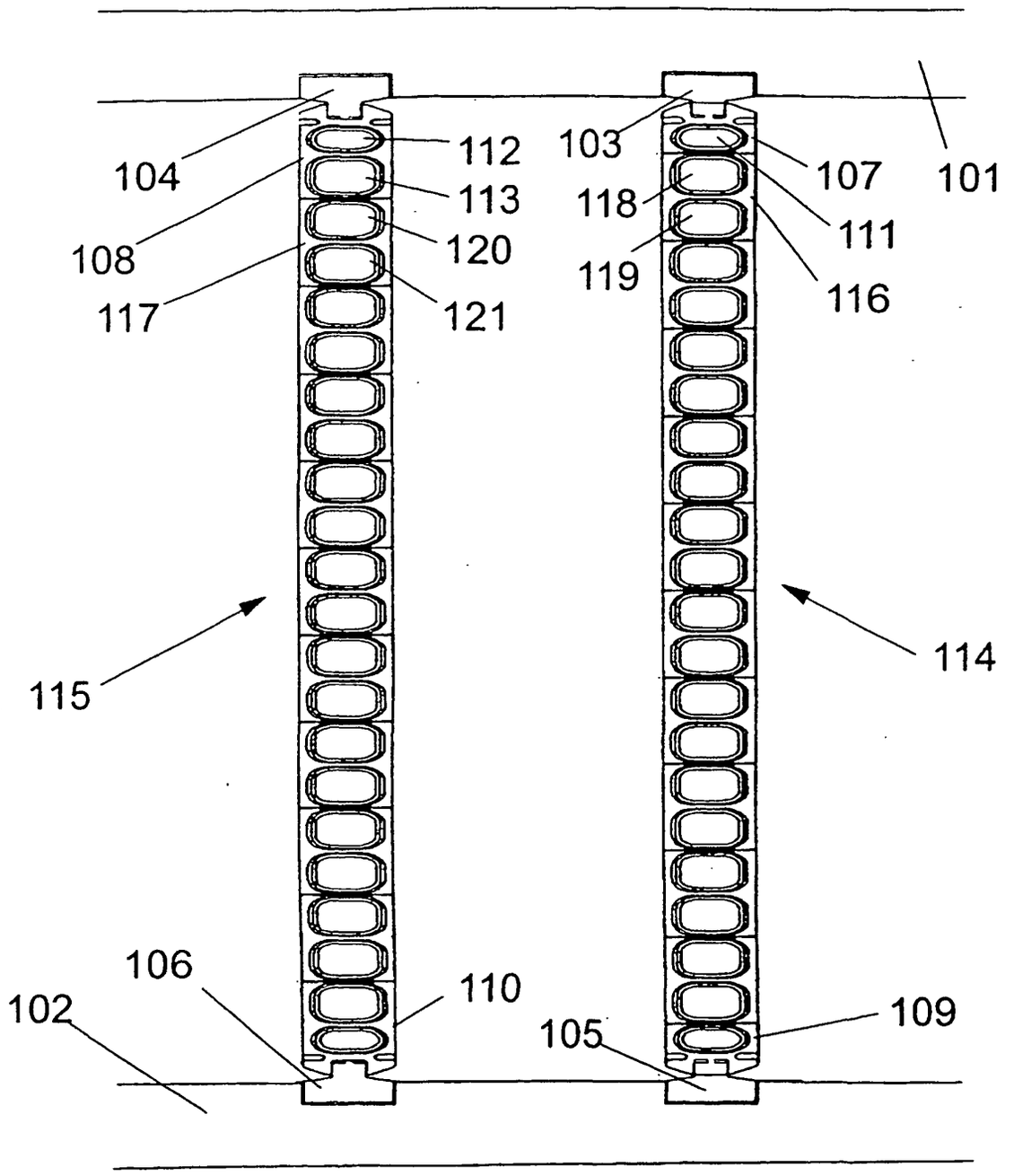

104
112
103
107
101
113
118
111
108
120
119
117
121
116
115
114
106
110
102
109
105

Fig. 2

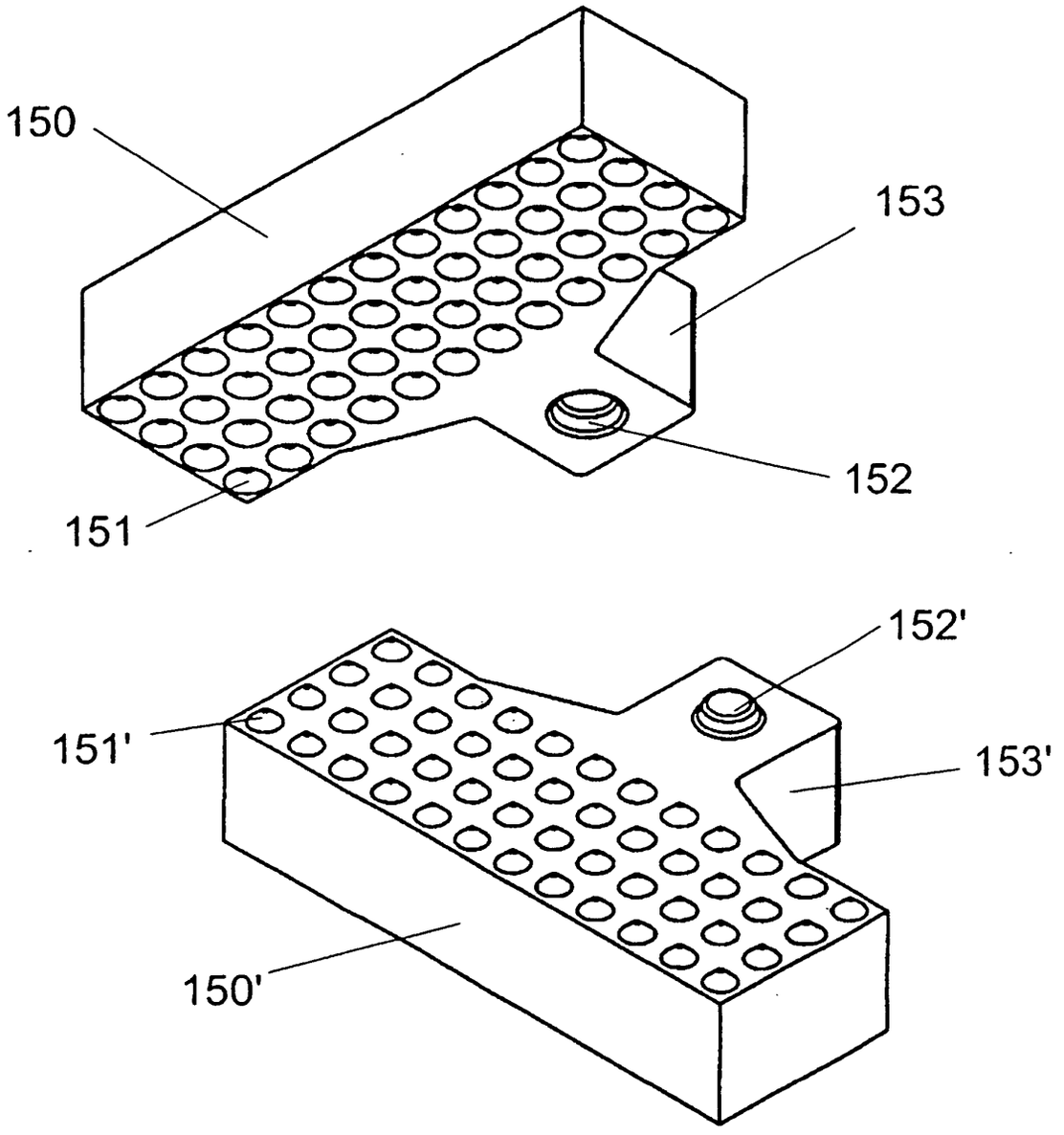
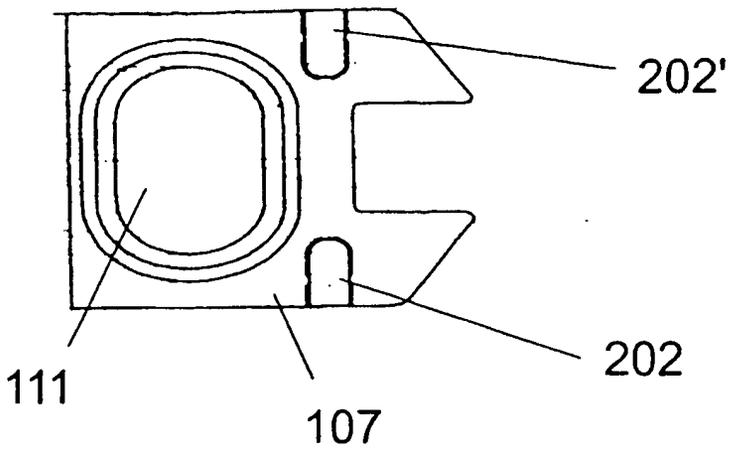


Fig. 3



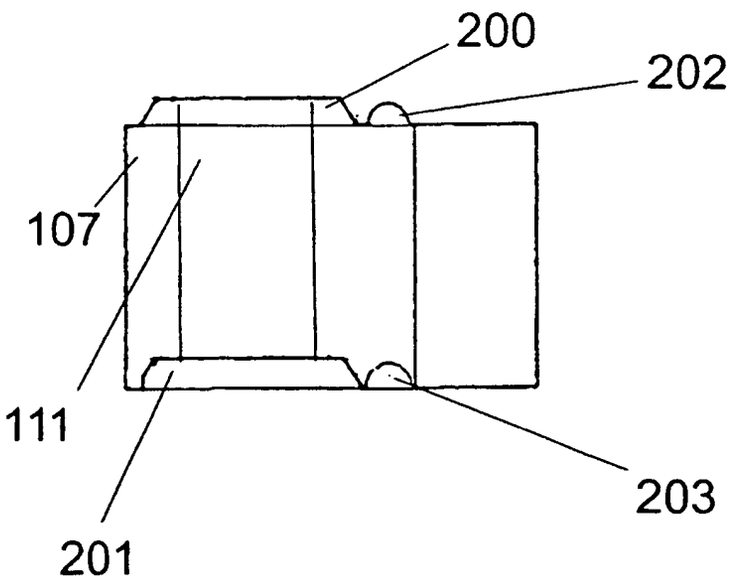


Fig. 4

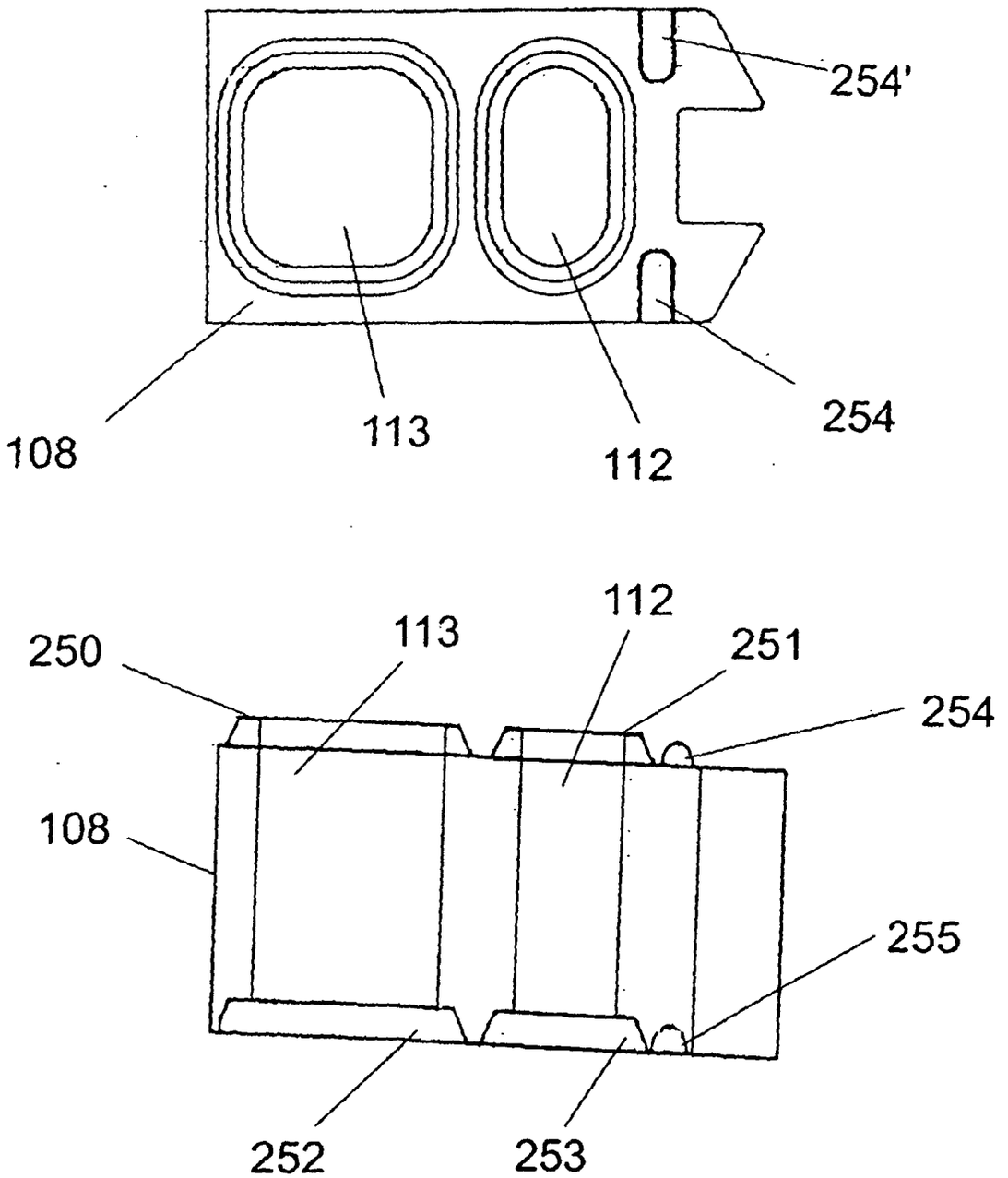
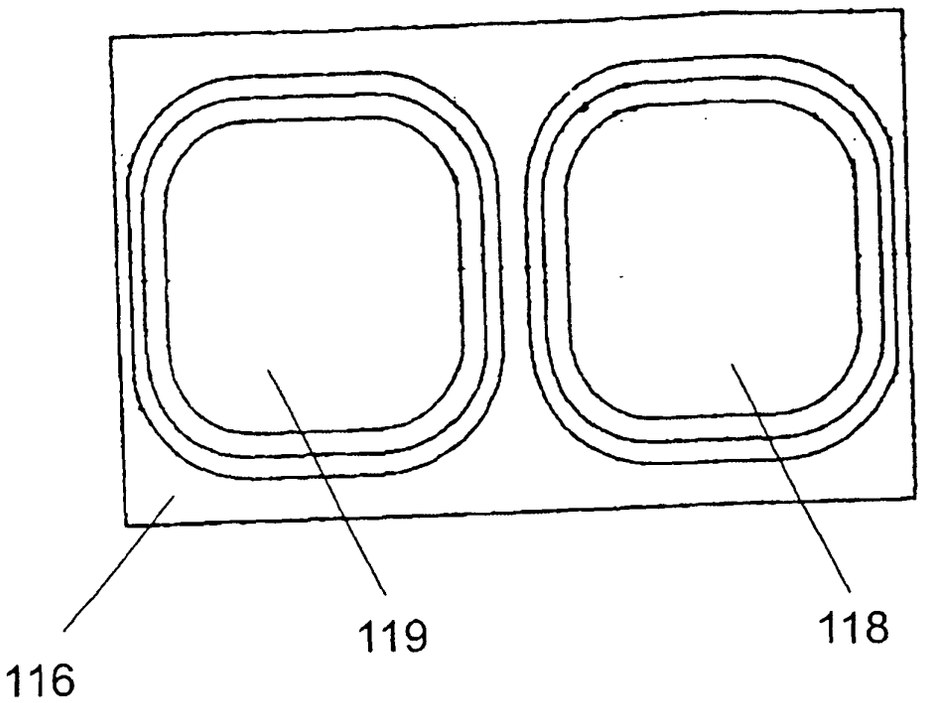


Fig. 5



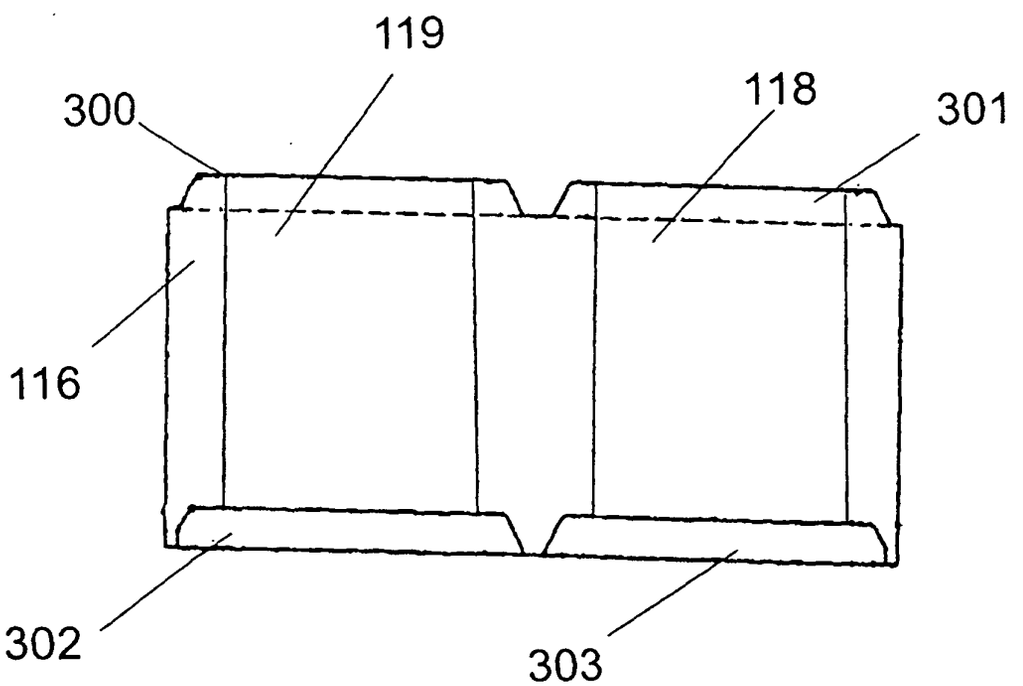


Fig. 6