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(54) **A METHOD FOR CREATING A THERMALLY STABLE BASE STRUCTURE AND FURNACE COMPRISING A THERMALLY STABLE STRUCTURE**

VERFAHREN ZUR SCHAFFUNG EINER WÄRMESTABILEN BASISKONSTRUKTION UND OFEN MIT EINER WÄRMESTABILEN BASISKONSTRUKTION

PROCEDE DE FABRICATION D'UNE STRUCTURE DE BASE THERMOSTABLE ET FOUR COMPRENANT UNE STRUCTURE DE BASE THERMOSTABLE

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Description

[0001] The present invention concerns a method for creating a thermally stable base structure which may form part of furnaces such as ring section furnaces for calcining of carbon blocks for use in aluminium electrolysis. Moreover, the present invention comprises a furnace in which the base structure has proved to remain stable over long-term operation with high mechanical and thermal loads.

[0002] Carbon blocks such as those stated above might have a considerable weight of several tonnes and a length of 1.5 metres or more, depending on whether they are to be used as anode or cathode elements in the electrolysis cells (see e.g. DE-U1-2002167). US-A-5 676 540 discloses an interlocking brick system for flue walls of a furnace.

[0003] The carbon blocks are loaded into the furnace in deep shafts called cassettes or pits with walls constructed of refractory brick work. The gap between the carbon blocks and the cassette walls is filled with packing material, for example coke, to provide good support (stabilising of) for the carbon blocks. The packing coke serves also to protect the carbon blocks against air bum.

[0004] Several cassettes are built next to each other and form a section. The walls between the cassettes are provided with ducts for firing gases and heat is supplied to the carbon blocks by conducting firing gases through these ducts.

[0005] The firing gases from a section are conducted to an adjacent section in the direction of firing via passages arranged in or under head walls located between the sections. In this way, the firing gases may be drawn through several sections connected in series in the preheating, firing and cooling zones.

[0006] Furnaces of this type may comprise horizontal firing gas ducts in the space below the base of the cassettes while there is free gas conduction in the space between the section cover and the cassettes. The firing gas ducts in the cassette walls connect the space below the section cover with the spaces below the base of the cassettes.

[0007] Moreover, a section may be divided into two parts by a barrier wall in the space below the cassettes. The firing gases are then conducted up through one half and down through the other half in the ducts of the cassette walls in the direction of firing.

[0008] On account of the special properties of the carbon blocks, during calcining it is necessary to avoid large temperature gradients which may cause cracks in the finished product. Each section must, therefore, follow precisely the time/temperature curve defined for the ring section furnace.

[0009] The first phase of the heat supply to a section takes place in the preheating zone, where the carbon blocks reach up to approximately 600°C by means of the heat in the firing gases from the last part of the firing zone. Later, in the temperature interval from 600°C to the desired operating temperature of 1200-1300°C, heat must be supplied by the stated combustion of gas, oil and binding material.

[0010] In closed ring section furnaces, the fuel can either be supplied in separate vertical firing shafts in the head walls or fully or partially in the space above and/or below the cassettes, as shown in the applicant's own patent nos. 152029 and 174364.

[0011] One problem related to optimal control of a ring section furnace is that it depends on the condition of the brick work and firing gas ducts not being too worn so that large leaks occur.

[0012] One part of the brick work which is particularly exposed is the base structure of the cassettes. When the carbon blocks are inserted, the base will be loaded with several tonnes. Moreover, during the calcining process, the temperature may exceed 1500°C in parts of the structure. In addition to having to have high mechanical strength, it is important for the base structure to constitute an effective sealing surface against firing gas ducts installed below the base so that uncontrolled bum in the cassette above does not occur. Another feature of the base structure is that gas ducts from the cassette walls which communicate with the space below the base structure pass through it. These ducts should be in sealing contact with the base so that firing gas does not leak into the cassettes.

[0013] One purpose of the present invention is for the above properties to be provided even with large thermal cycles, and the base is constructed in such a way that it can withstand high mechanical and thermal loads.

[0014] According to the present invention, the above problems and purposes are solved and achieved by a method according to claim 1 and a furnace according to claim 6.

[0015] Preferred embodiments are given in the dependent claims.

[0016] The present invention will be described in further detail in the following with examples and figures, where:

Fig. 1 shows a cross section of a section in a furnace,

Fig. 2 shows a plan view of a section in a furnace, seen from above,

Fig. 3a shows an enlarged cross section of a part of a section as shown in Fig. 1,

Fig. 3b shows further details in connection with the construction of a base structure equivalent to the one shown in Fig. 3a,

Fig. 4 shows an enlarged plan view of a part of a section as shown in Fig. 2, seen from above, in which the section is taken below the base of the cassettes,

Fig. 5 shows a longitudinal section of the section as shown in Fig. 4,

Fig. 6 shows details in connection with the construction of a base structure.

[0017] Figure 1 shows a cross section of a section in a furnace. The section 1 comprises an outer case 2, which is lined with brick work at the sides 3, 5 and at the base of the furnace 4. The figure also shows cassette walls 6, 7, 8, 9, 10, 11, 12, 13, 14, which are equipped with firing gas ducts. A number of columns 15, 16, 17 rest on the base 4. They support part 18 of the base structure. Accordingly, the columns 19, 20, 21 support part 22 of the base structure. Between parts 18 and 22 there is an opening 23 through which firing gas may pass and communicate with the firing gas ducts in cassette wall 7. Three layers of carbon blocks K are shown inserted in the cassette between cassette walls 10 and 11.

[0018] Figure 2 shows plan view of a section in a furnace, seen from above. As the figure shows, the cassette walls 6, 7, 8, 9, 10, 11, 12, 13, 14 are fixed to head walls 30, 31 at their ends. Moreover, carbon blocks K are shown inserted in the cassette between cassette walls 9 and 10.

[0019] Figure 3a shows an enlarged cross section of a part of a section as shown in Figure 1, where an outer case 2 is lined with brick work 5 at its side and with brick work 4 at its base. Moreover, the figure shows three columns 15, 16, 17, which support a part 18 of the base structure, and columns 19, 20, 21, which support part 22 of the base structure. The opening 23 between the base parts 18, 22 communicates with the firing gas duct (s) 24 which run(s) from the bottom to the top in the cassette wall 7. The other cassette walls are arranged accordingly. The cassette walls may expediently consist of wall structures as shown in the applicant's own Norwegian patent application no. NO 20012044, and rest against recesses 27, 28 arranged in the base parts 18, 22. The opening 23 shown may run as a continuous gap along the full length of the section.

[0020] As partially shown in the figure, the base parts 18 and 22 are built up of two layers B', C' of refractory bricks of a relatively large area in relation to their thickness. The bricks' adjacent surfaces are expediently made with locking elements 25, 26 which contribute to the bricks in the two layers locking together. The locking elements may consist of interacting elevations/recesses which are adapted to each other and fit together. Several alternative embodiments may be used. For example, the locking elements may consist of longitudinal and transverse beads/cutouts or they may consist of rotationally symmetrical elevations/recesses equivalent to that stated in the applicant's own patent application no. PCT/NO99/00370.

[0021] Figure 3b shows further details in connection with the construction of a base structure equivalent to the one shown in Figure 3a, in which four columns 15, 16, 17, 18 are shown. A construction of a base structure with two layers C', B' of refractory bricks comprises bricks with locking elements 25, 26. The figure also shows expansion joints 60, 61 which may be arranged between the bricks. In this embodiment example, the refractory brick 62 is not equipped with locking elements against the underlying bricks 64, 65 so that the layers C', B' may have the necessary mobility in relation to the expansion joints. Moreover, the figure shows the shape of an end brick 63, which is designed as the termination of the two layers against an adjacent brick in a firing gas duct in a cassette wall (not shown). Accordingly, end bricks 66, 67 are shown. They interact with a brick 24' which constitutes part of a firing gas duct in a cassette wall.

[0022] Figure 4 shows an enlarged plan view of a part of a section as shown in Figure 2, seen from above, in which the section is taken below the base of the cassettes. As in Figure 2, head walls 30, 31 are shown. They limit the length of the section. Moreover, a number of columns are shown. For the sake of simplicity, only columns 15, 16, 17, 19, 20, 21 and columns 33, 34, 35, 36, 37 are indicated with reference numbers. The space below the base structure of the cassettes is closed in terms of gas flow by means of a tight barrier wall 32 at the centre of the section, which causes the firing gases to be forced up through the cassette walls in the first half of the section and down again in the next half.

[0023] Figure 5 shows a longitudinal section of a section as shown in Figure 4. The figure also shows a base structure 38 which rests on the columns. The figure shows columns 15, 33, 34, 35, 36, 37, which rest on the base of the furnace 4. Moreover, the figure shows the partition wall 32 and the base structure 38. At its ends 39, 40, the base structure is fixed to adjacent head walls (not shown) with an expansion/contraction joint.

[0024] Figure 6 shows details in connection with the construction of a base structure where only a section of the base is shown, seen from above. The figure shows the barrier wall 32 and (only partially) columns 15, 17, 33, 34, 35, 36, 37 and 16. The figure is intended to illustrate the construction of the base structure, and rows A, B, C show the various stages of this construction. In row A, the installation of a layer of edge bricks 50, 50' is shown. The place where a gap 23 is formed between edge bricks 50' and 50" forms the base of the cassette walls (see Figure 3). In row B, a row of bricks 51 is shown laid between the rows of edge bricks 50" and 50"'. The area of the bricks is indicated by black lines which together form a rectangular shape. The figure shows that each brick may have a network of locking elements, and in the centre part of the row this may comprise longitudinal and transverse beads/grooves 52, 53.

[0025] In row C, the second, concluding layer is laid. In the same way as in the previous row, the individual bricks are shown by continuous black lines in rectangular shapes. Underneath this layer are interacting locking

elements which lock with complementary elements in the layer shown in row B. Moreover, the bricks are designed so that none of the end edges coincides with end edges of bricks in the layer underneath.

[0026] In this way, a stable base structure may be created in which, in principle, every single brick is locked permanently to one or more adjacent bricks with the exception of the creation of any expansion joints, where adjacent bricks must be able to move in the appropriate manner as described under Figure 3b.

[0027] The size of the bricks is adapted to the bearing surface constituted by the top surface of the columns and the joints between the bricks are laid in such a way that the strength properties of the floor are optimised.

Claims

1. A method for creating a thermally stable base structure (38) which is suitable as a part of furnaces such as ring furnaces for calcining of carbon blocks for use in aluminium electrolysis, where the base structure comprises layers of refractory bricks and rests on a foundation consisting of a number of columns (15, 16, 17, 18, 19, 20),
   characterised in that
   a first layer B' of refractory bricks is created, which rests on the foundation, the bricks are made with locking elements (25, 26) on their tops, onto which is laid a second layer C' of refractory bricks with equivalent, complementary locking elements underneath them so that the two layers remain at least partially connected to each other.

2. A method in accordance with claim 1,
   characterised in that
   the locking elements are designed as longitudinal and transverse beads/grooves (52, 53) arranged in the bricks' adjacent surfaces.

3. A method in accordance with claim 1,
   characterised in that
   the base structure (38) is created from several parts (18, 22) which are arranged in such a way that a gap (23) is formed between them, the gap is designed for communication with firing gas ducts (24) in a cassette wall (7) and the space below the base structure (38).

4. A method in accordance with claims 1-3,
   characterised in that
   expansion/contraction of the base structure in the longitudinal direction of the section is permitted at the ends (39, 40) of the base structure, where it is fixed to adjacent head walls (30, 31).

5. A method in accordance with claims 1-3,
   characterised in that
   expansion/contraction of the base structure in the transverse direction of the section is permitted by expansion joints (60, 61) arranged between bricks in layers B', C' in the base structure.

6. Furnace such as a ring furnace for calcining of carbon blocks for use in aluminium electrolysis comprising a thermally stable base structure (38), where the base structure rests on a foundation consisting of a number of columns (15, 16, 17, 18, 19, 20),
   characterised in that
   the base structure is built up of at least two layers B', C' of refractory bricks which are equipped with locking elements (25, 26) on their adjacent sides so that the bricks are at least partially connected to each other.

7. Furnace in accordance with claim 6,
   characterised in that
   the locking elements consist of longitudinal and transverse beads/grooves (52, 53) arranged in the adjacent surfaces of the bricks.

8. Furnace in accordance with claim 6,
   characterised in that
   the locking elements consist of rotationally symmetrical elevations/recesses.

9. Furnace in accordance with claim 6,
   characterised in that
   the base structure (38) comprises several parts (18, 22) which are arranged in such a way that a gap (23) is formed between them and the gap forms the connection between the space below the base structure and firing gas ducts (24) in a cassette wall (7).

10. Furnace in accordance with claim 6,
    characterised in that
    the base structure comprises expansion joints (60, 61) between adjacent bricks.

Patentansprüche

1. Verfahren zum Herstellen einer thermisch stabilen Basisstruktur (38), die sich als ein Teil von Öfen, wie beispielsweise Ringöfen, zum Kalzinieren von Kohlenstoffblöcken zur Verwendung bei der Aluminiumelektrolyse eignet, wobei die Basisstruktur Schichten aus feuerfesten Ziegeln umfasst und auf einem Fundament ruht, das aus einer Anzahl von Säulen (15, 16, 17, 18, 19, 20) besteht, **dadurch gekennzeichnet, dass** eine erste Schicht B' aus feuerfesten Ziegeln, die auf dem Fundament ruht, hergestellt ist, wobei die Ziegel auf ihren Oberseiten mit Verriegelungselementen (25, 26) versehen sind, worauf eine zweite Schicht C' aus feuerfesten Zie-

geln mit darunter angeordneten äquivalenten, komplementären Verriegelungselementen gelegt ist, dergestalt, dass die beiden Schichten wenigstens teilweise miteinander verbunden bleiben.

2. Verfahren nach Anspruch 1,**dadurch gekennzeichnet, dass** die Verriegelungselemente als in Längs- und Querrichtung verlaufende Rippen und Nuten (52, 53) gestaltet sind, die in den benachbarten Flächen der Ziegel angeordnet sind.

3. Verfahren nach Anspruch 1,**dadurch gekennzeichnet, dass** die Basisstruktur (38) aus mehreren Abschnitten (18, 22) hergestellt wird, die dergestalt angeordnet sind, dass zwischen ihnen ein Spalt (23) gebildet wird, wobei der Spalt für eine strömungsmäßige Verbindung mit Feuerungsgaskanälen (24) in einer Kassettenwand (7) und dem Raum unterhalb der Basisstruktur (38) konfiguriert ist.

4. Verfahren nach den Ansprüchen 1 bis 3,**dadurch gekennzeichnet, dass** an den Enden (39, 40) der Basisstruktur, wo sie an benachbarten Stirnwänden (30, 31) befestigt ist, eine Ausdehnung bzw. Kontraktion der Basisstruktur in Längsrichtung der Sektion ermöglicht wird.

5. Verfahren nach den Ansprüchen 1 bis 3,**dadurch gekennzeichnet, dass** durch Dehnungsfugen (60, 61), die zwischen Ziegeln in den Schichten B', C' in der Basisstruktur angeordnet sind, eine Ausdehnung bzw. Kontraktion der Basisstruktur in Querrichtung der Sektion ermöglicht wird.

6. Ofen, wie beispielsweise ein Ringofen, zum Kalzinieren von Kohlenstoffblöcken zur Verwendung bei der Aluminiumelektrolyse, umfassend eine thermisch stabile Basisstruktur (38), wobei die Basisstruktur auf einem Fundament ruht, das aus einer Anzahl von Säulen (15, 16, 17, 18, 19, 20) besteht, **dadurch gekennzeichnet, dass** die Basisstruktur aus wenigstens zwei Schichten B', C' aus feuerfesten Ziegeln aufgebaut ist, die auf ihren benachbarten Seiten mit Verriegelungselementen (25, 26) versehen sind, dergestalt, dass die Ziegel wenigstens teilweise miteinander verbunden sind.

7. Ofen nach Anspruch 6,**dadurch gekennzeichnet, dass** die Verriegelungselemente aus in Längs- und Querrichtung verlaufenden Rippen und Nuten (52, 53) bestehen, die in den benachbarten Flächen der Ziegel angeordnet sind.

8. Ofen nach Anspruch 6,**dadurch gekennzeichnet, dass** die Verriegelungselemente aus rotationssymmetrischen Erhöhungen und Ausnehmungen bestehen.

9. Ofen nach Anspruch 6,**dadurch gekennzeichnet, dass** die Basisstruktur (38) mehrere Abschnitte (18, 22) aufweist, die dergestalt angeordnet sind, dass zwischen ihnen ein Spalt (23) gebildet wird und dass der Spalt die Verbindung zwischen dem Raum unterhalb der Basisstruktur und Feuerungsgaskanälen (24) in einer Kassettenwand (7) bildet.

10. Ofen nach Anspruch 6,**dadurch gekennzeichnet, dass** die Basisstruktur Dehnungsfugen (60, 61) zwischen benachbarten Ziegeln aufweist.

Revendications

1. Procédé pour la production d'une structure de base thermostable (38) qui convient comme partie de fours, tels que des fours annulaires, pour calciner des blocs de carbone destinés à un usage en électrolyse d'aluminium, où la structure de base comprend des couches de briques réfractaires et repose sur une fondation constituée d'un certain nombre de colonnes (15, 16, 17, 18, 19, 20),
caractérisé en ce que
on forme une première couche B' de briques réfractaires qui repose sur la fondation et dont les briques sont fabriquées avec des éléments de verrouillage (25, 26) sur leurs parties supérieures, sur laquelle couche est appliquée une deuxième couche C' de briques réfractaires avec des éléments de verrouillage complémentaires équivalents ménagés en dessous de celles-ci afin que les deux couches restent au moins en partie raccordées l'une à l'autre.

2. Procédé selon la revendication 1,
caractérisé en ce que
les éléments de verrouillage sont conçus sous la forme de nervures/rainures longitudinales et transversales (52, 53) aménagées dans les surfaces adjacentes des briques.

3. Procédé selon la revendication 1,
caractérisé en ce que
la structure de base (38) est formée de plusieurs parties (18, 22) qui sont aménagées de sorte qu'un intervalle (23) soit ménagé entre elles, l'intervalle étant conçu pour permettre une communication avec des conduits de gaz de combustion (24) dans une paroi de cassette (7) et l'espace situé en dessous de la structure de base (38).

4. Procédé selon les revendications 1 à 3,
caractérisé en ce que
une dilatation/contraction de la structure de base dans la direction longitudinale de la section est autorisée aux extrémités (39, 40) de la structure de base, où elle est fixée aux parois de tête adja-

centes (30, 31).

5. Procédé selon les revendications 1 à 3,
caractérisé en ce que
une dilatation/contraction de la structure de base dans la direction transversale de la section est autorisée par des joints de dilatation (60, 61) aménagés entre les briques des couches B', C' de la structure de base.

6. Four tel qu'un four annulaire pour calciner des blocs de carbone destinés à un usage en électrolyse d'aluminium, comprenant une structure de base thermostable (38), où la structure de base repose sur une fondation constituée d'un certain nombre de colonnes (15, 16, 17, 18, 19, 20),
caractérisé en ce que
la structure de base est formée d'au moins deux couches B', C' de briques réfractaires qui sont équipées d'éléments de verrouillage (25, 26) sur leurs côtés adjacents de sorte que les briques soient au moins en partie raccordées l'une à l'autre.

7. Four selon la revendication 6,
caractérisé en ce que
les éléments de verrouillage sont constitués de nervures/rainures longitudinales et transversales (52, 53) aménagées dans les surfaces adjacentes des briques.

8. Four selon la revendication 6,
caractérisé en ce que
les éléments de verrouillage sont constitués de saillies/rainures à symétrie de rotation.

9. Four selon la revendication 6,
caractérisé en ce que
la structure de base (38) comprend plusieurs parties (18, 22) qui sont aménagées de sorte qu'un intervalle (23) soit formé entre elles et que l'intervalle forme la liaison entre l'espace situé en dessous de la structure de base et les conduits de gaz de combustion (24) dans une paroi de cassette (7).

10. Four selon la revendication 6,
caractérisé en ce que
la structure de base comprend des joints de dilatation (60, 61) entre les briques adjacentes.

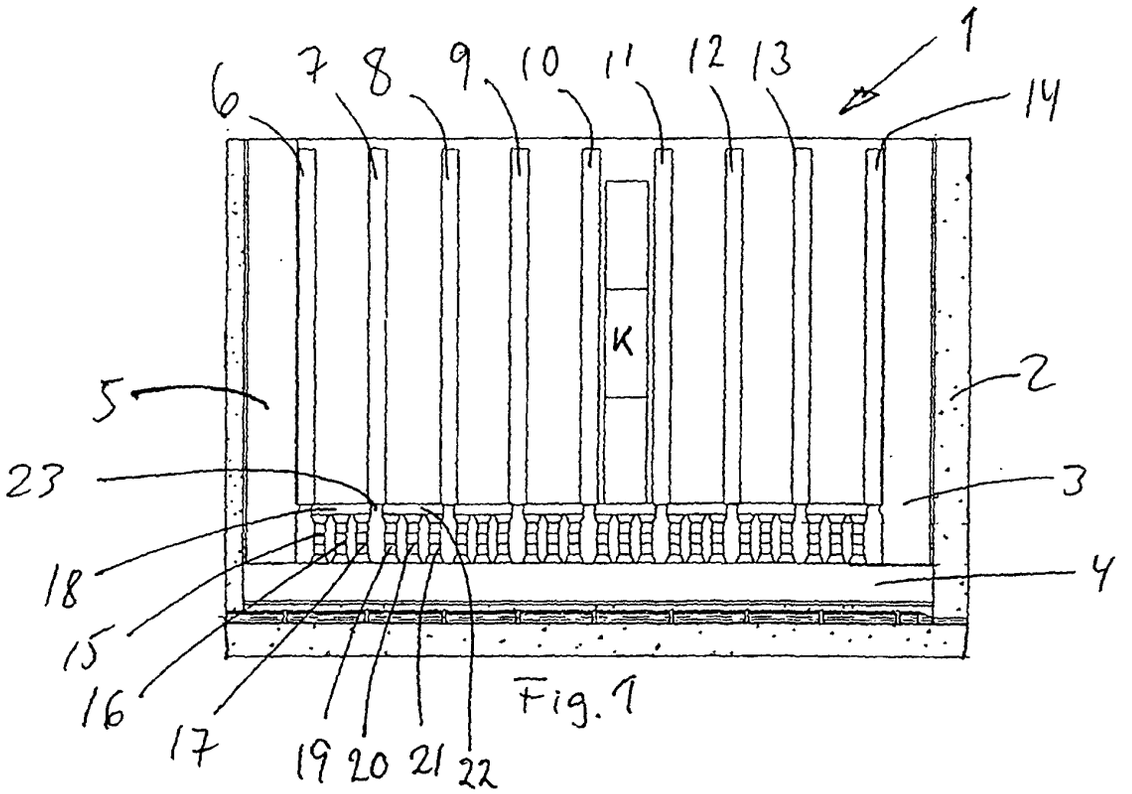
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Fig. 1

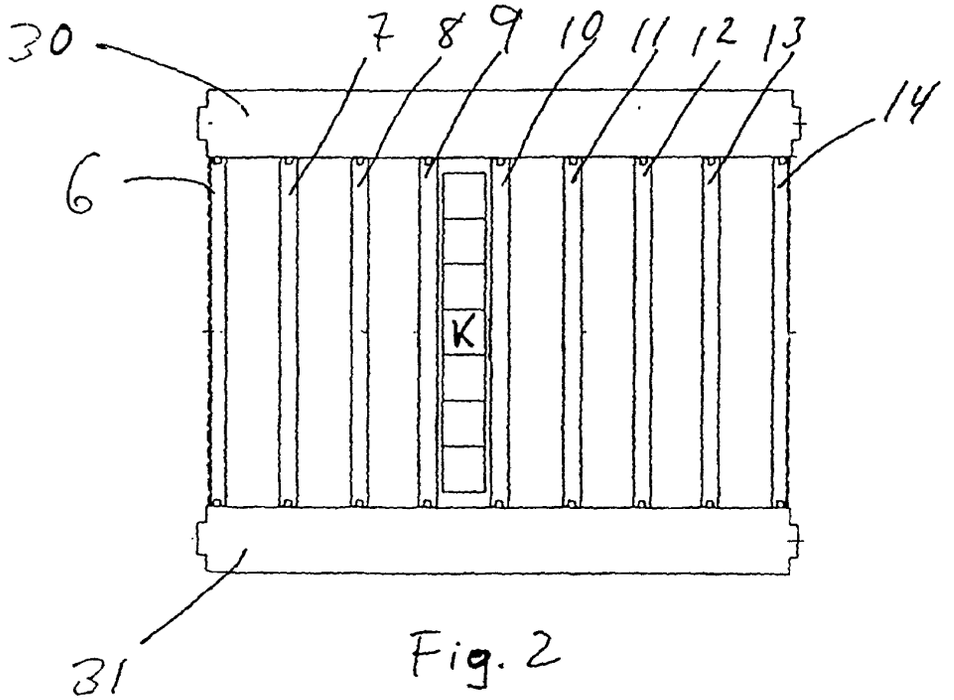
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Fig. 2

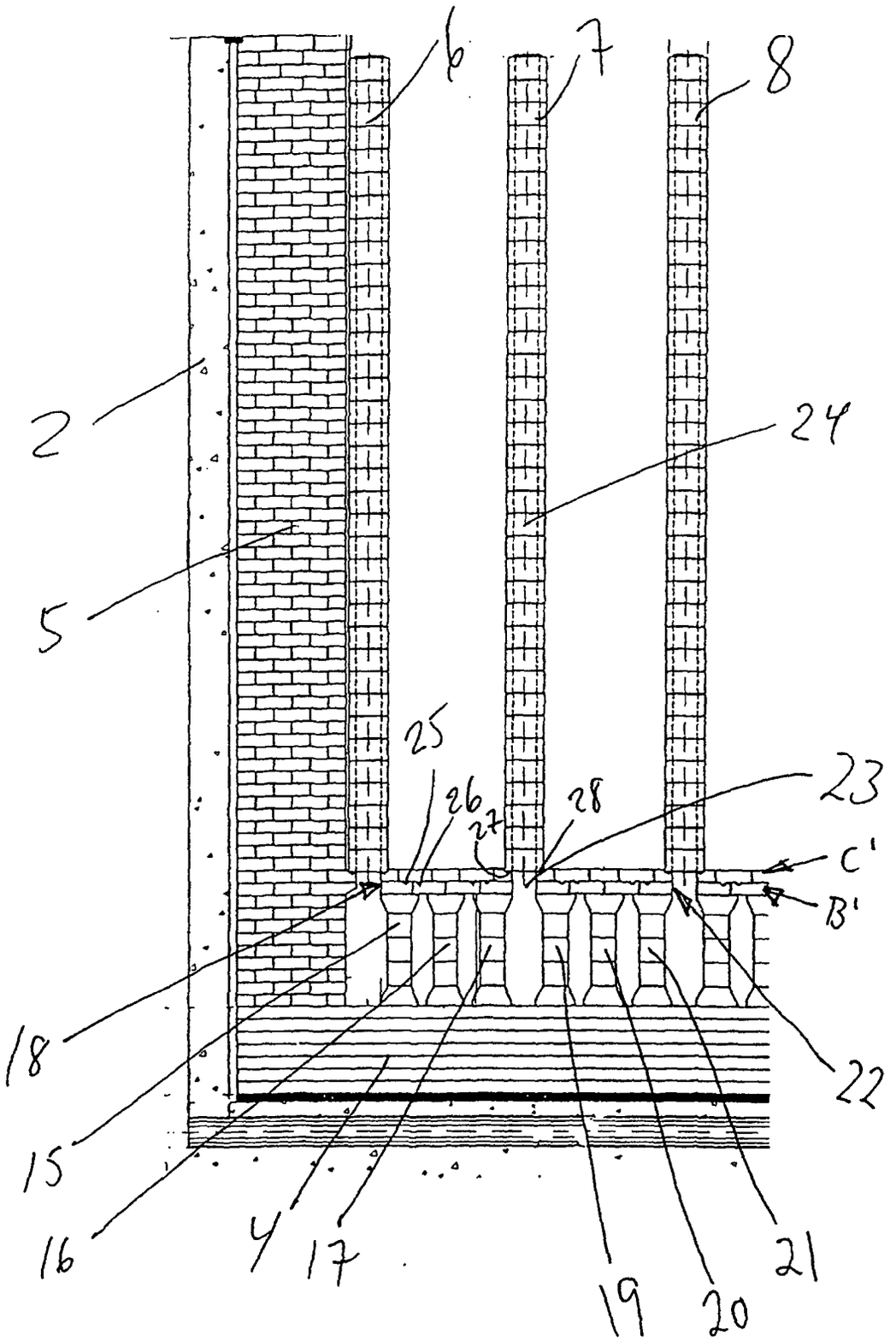

Fig. 3a

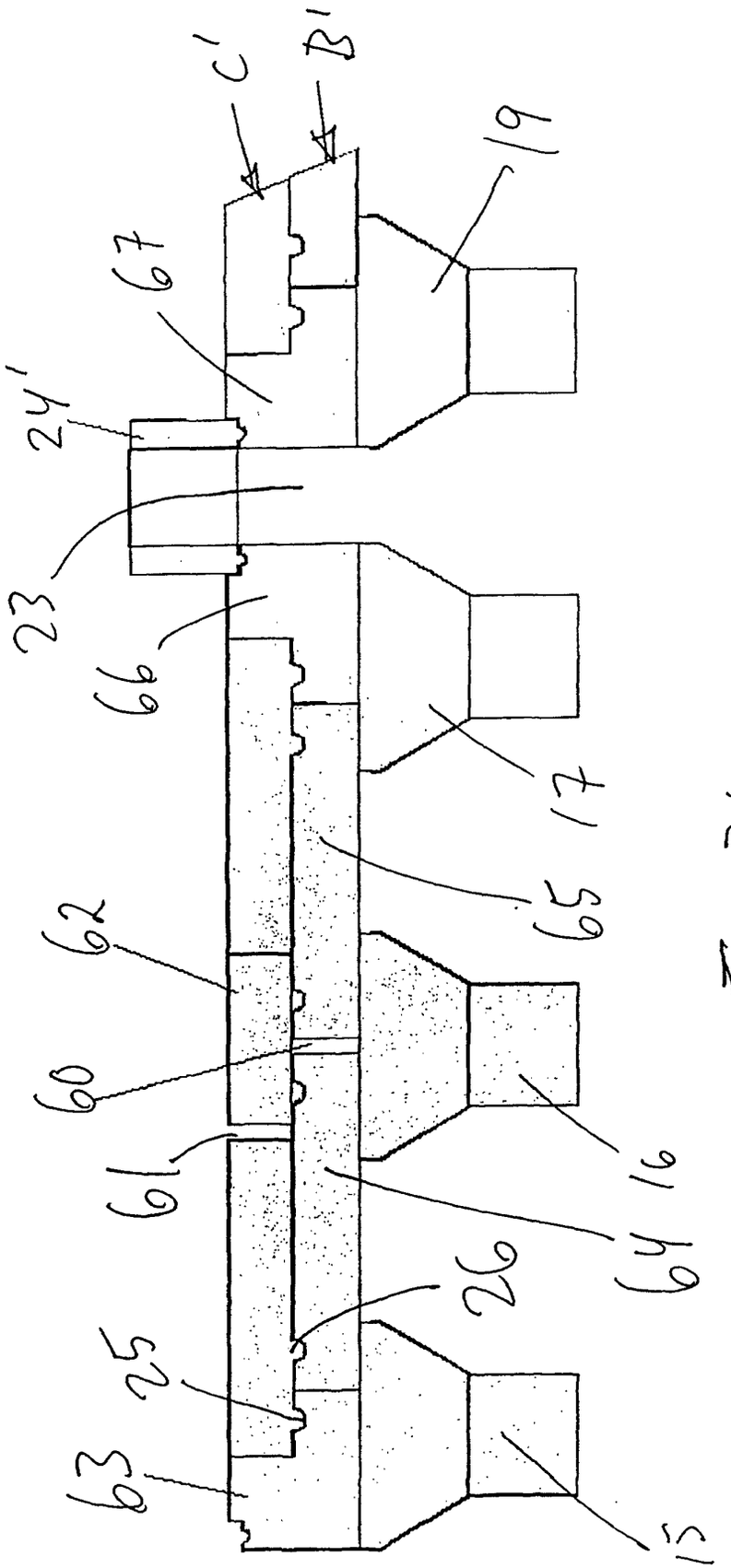

Fig. 3b

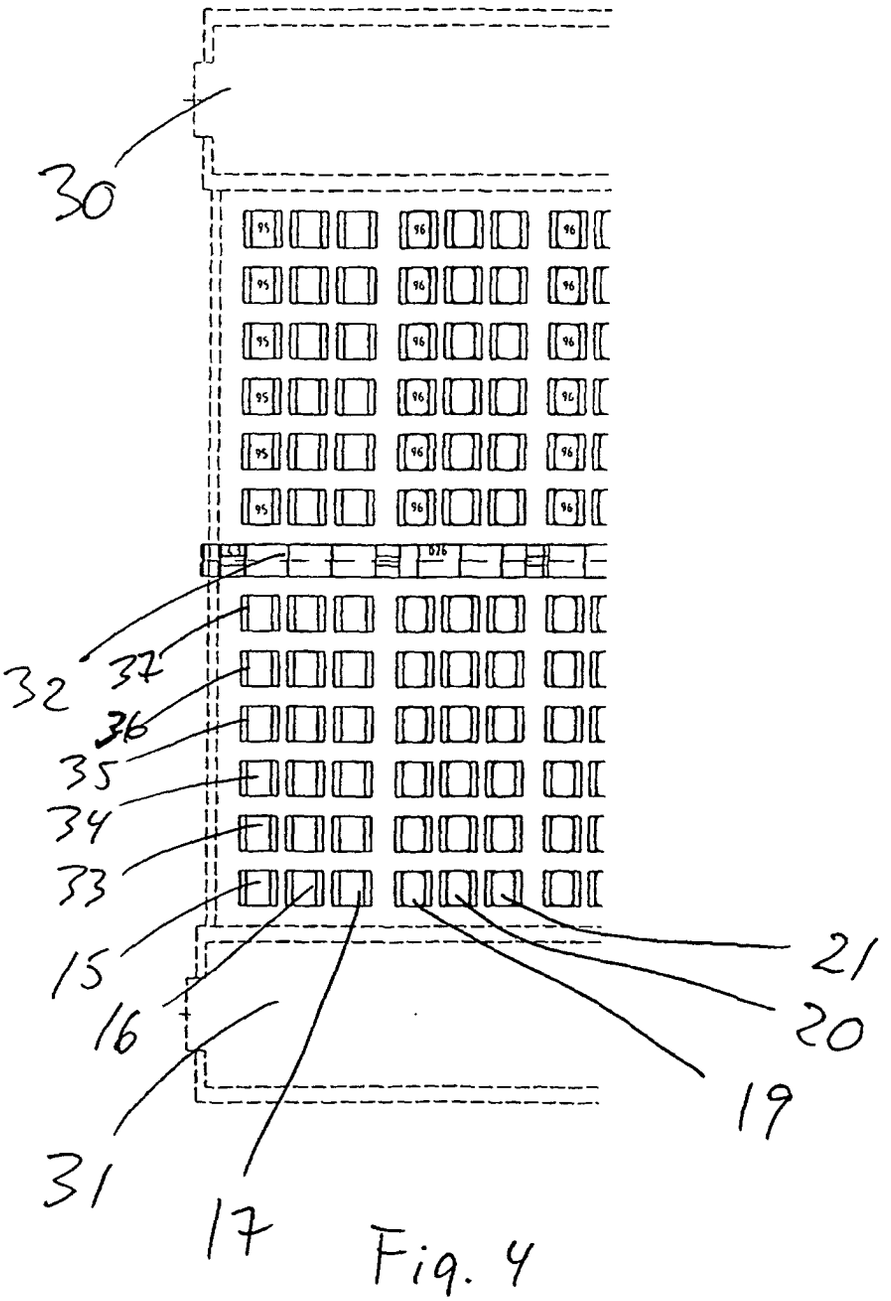

Fig. 4

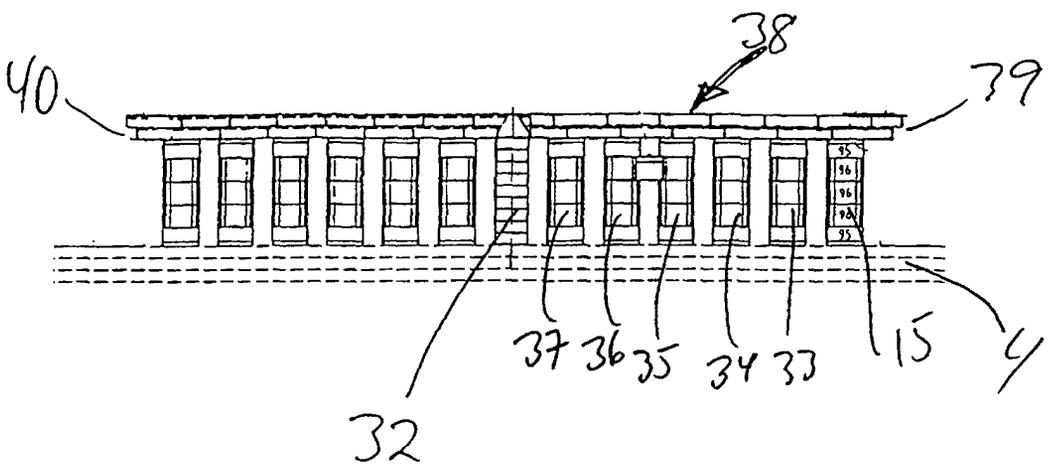

Fig. 5

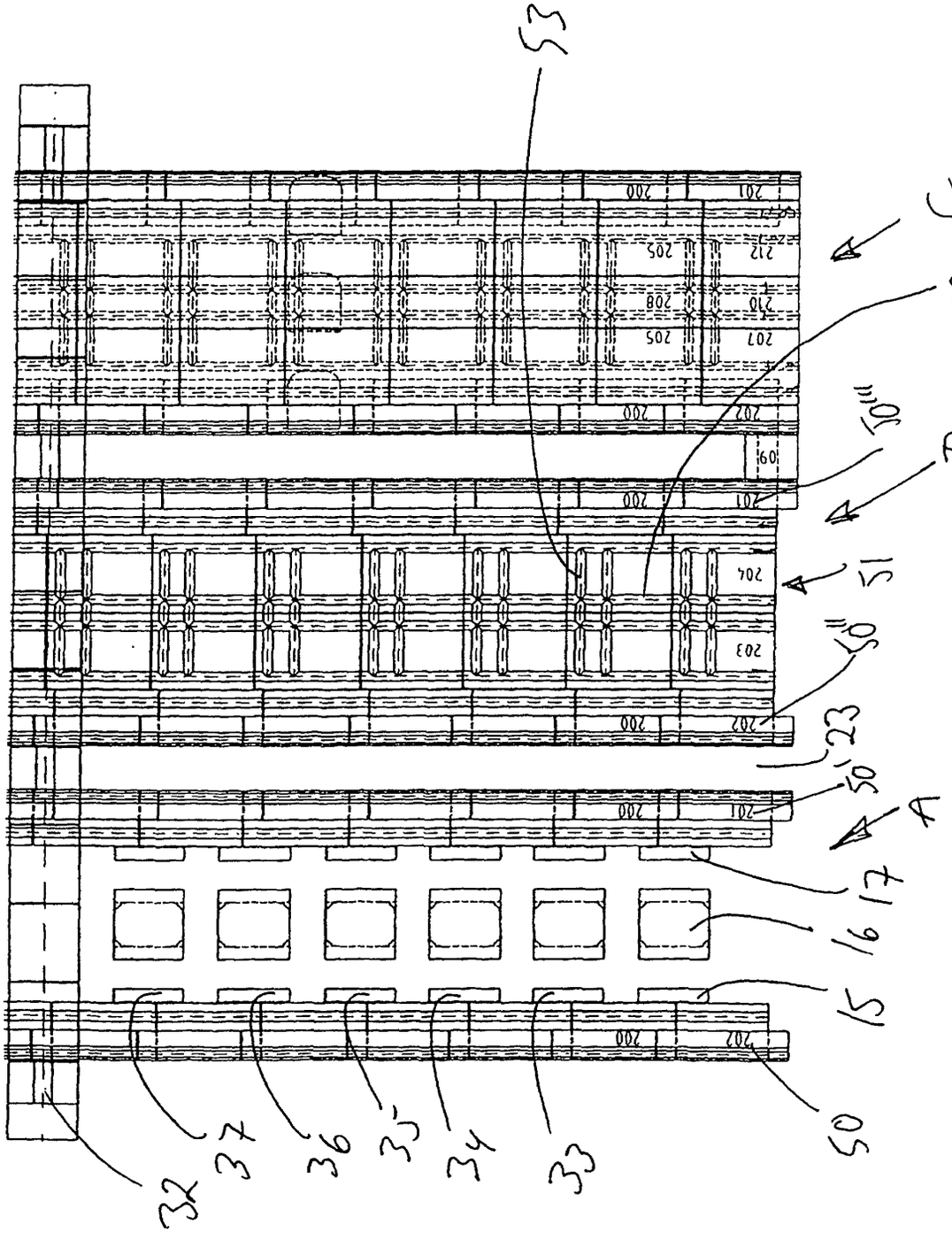

Fig. 6