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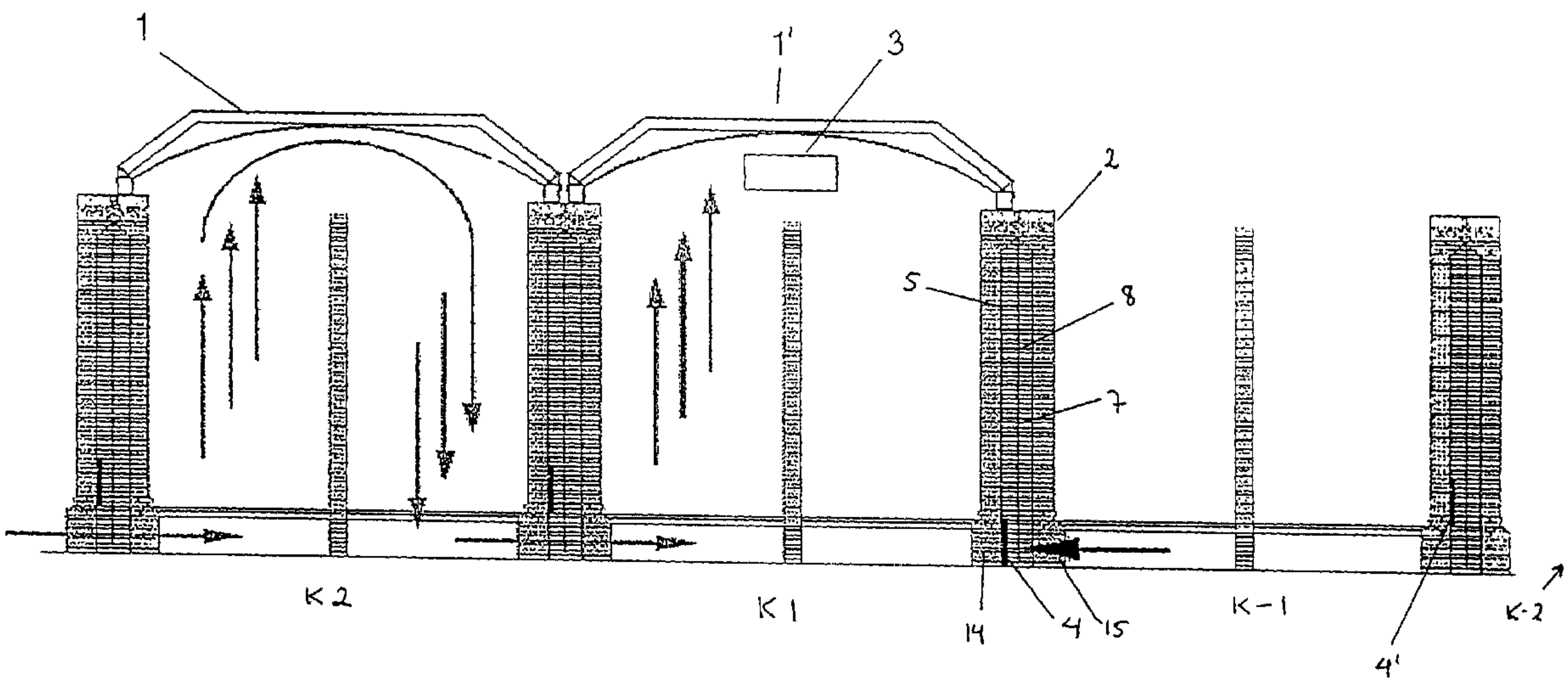
(54) Title: A METHOD FOR OPERATING RING-FURNACES AND A DEVICE FOR SUCH OPERATION



(57) Abrégé/Abstract:
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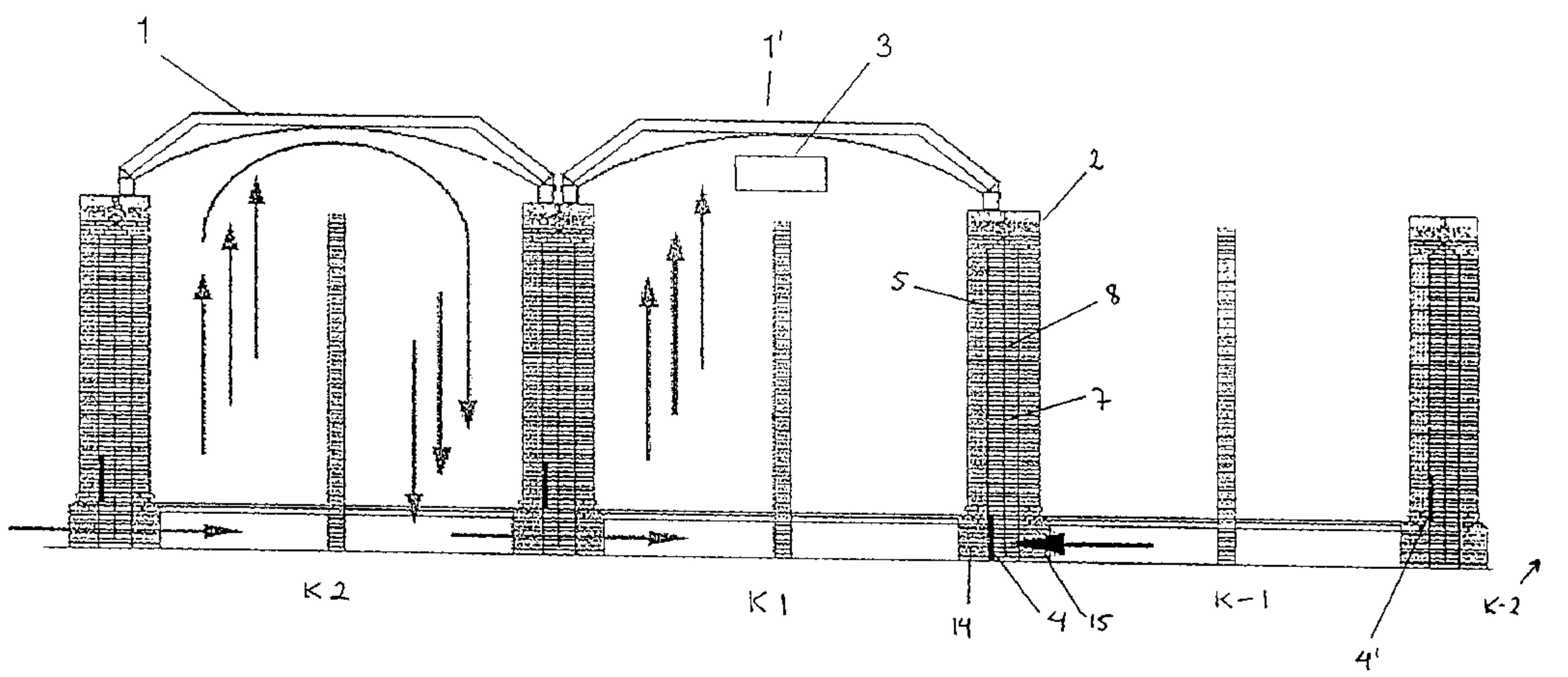
(54) Title: A METHOD FOR OPERATING RING-FURNACES AND A DEVICE FOR SUCH OPERATION



(57) Abstract: The present invention concerns a method and device for closing off one or more passages in a ring furnace for calcining of carbon bodies in which the furnace, during the calcining process, over an area comprising a small number of sections, is divided into a preheating zone, a firing zone and a cooling zone, which are together successively moved forwards in the furnace. In order to control the false air intake from a first section (K-1) before the preheating zone to the first section (K1) in the preheating zone, one or more lowerable air dampers (4) are placed in the head wall (2). When the air damper (4) or air dampers is/are lowered, it/they blocks/block the supply of false air from the first section (K-1) before the preheating zone to the first section (K1) in the preheating zone.

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Amended Specification

The present invention concerns a method for closing off one or more passages in a ring furnace for calcining of carbon bodies in which the furnace, during the calcining process, over an area comprising a small number of sections, is divided into a preheating zone, a firing zone and a cooling zone, which are together successively moved forwards in the furnace. Further, the invention relates to such a furnace.

The purpose of the calcining process is to produce carbon blocks which are as homogeneous as possible with properties which are suitable for use in, for example, aluminium electrolysis. The carbon blocks are produced in the desired form from a mixture of crushed coke or anthracite and a binding material, for example pitch.

Such carbon blocks may 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.

The carbon blocks are loaded into in 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 burn.

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.

Each section may be closed by a section cover. The firing gases from a section are conducted to an adjacent section in the direction of firing via passages arranged in and/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. The fuels used are oil, gas and binding material. When volatiles from the binding material evaporates and seeps out into the furnace where combustion take place when ignition temperature is achieved. Pitch is used, in particular, as the binding material and the combustion of binding material accounts for up to 40% of the total energy input. The firing gas outlet is moved successively in the direction of firing.

In a ring section furnace, two rows of sections are built next to each other in parallel rows. At the end of one row of sections, the gas ducts are connected to the parallel row of sections. In this way, the sections are connected together to form a ring. This has given such furnaces the above name.

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.

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.

The firing zone moves in the direction of firing as stated above by moving oil or gas burners from the section in which the firing is completed to the section in which firing is to begin. The time interval for moving the firing gas outlet is called the fire advance.

Each section may be connected to a gas extraction system both to remove the combustion gases from the firing zone and to supply oxygen to the firing zone for complete combustion of oil or gas. This is done by connecting an exhaust manifold, which may be provided with an adjustment device, to a section in the preheating zone and to an exhaust gas ring main. Air from the surroundings is drawn through and into the firing zone and supplies it with sufficient oxygen and is drawn on through the preheating zone before the gas is transported on via the pipe and the adjustment device to the ring main and a purification system.

There are horizontal firing gas ducts in the space below the section while there is free gas conduction in the space between the section lid and the cassettes. The firing gas ducts in the cassette walls connect the space below the section cover with the spaces below the section.

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 No. 152029 and No. 174364.

In ring section furnaces, 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.

A ring furnace is controlled according to the temperature of the gas which flows through the sections. The temperature of the carbon blocks is lower than that of the gas and is a result of the heat transfer conditions in the furnaces. The heat transfer conditions depend primarily on the following factors: the section and cassette dimensions, the dimensions of the carbon blocks, the particle size and degree of packing of the packing coke, the gas quantity and velocity and the extent to which the carbon blocks are centred in the cassettes. A common feature of these factors is that over time they must be as constant as possible so that the difference between the gas temperature and the carbon block temperature is virtually constant.

This is the basic precondition for the ability to control the ring furnace according to the gas temperature. In practice, this means that if one or more of the above factors change over time, for example as a result of wear to the brick work and the introduction of false air, this must be compensated for in order to follow the time/temperature curve. Good utilisation of the energy value (thermal value) of the fuel requires that there is the right oxygen balance at all points in the firing zone in order to achieve complete combustion.

With balanced control of the process, it is possible to avoid thermal shock, i.e. rapid temperature changes in the carbon blocks and refractory structures, which may, over time, cause the formation of cracks and deformations, an increased number of rejected carbon blocks and increased maintenance of the refractory structures.

Firing gases which are created in the firing zone will be sucked out from the first section in the preheating zone via the exhaust manifold and will be conducted into the exhaust gas ring main. The consequence of this is that false air is drawn from the open, cold section next to the section where the adjustment device is mounted, and into the preheating zone. In turn, this causes partial cooling down of the preheating zone and a considerable decrease of the gas flow, i.e. from the cooling zone, through the firing zone to the preheating zone.

In the applicant's own Norwegian patent no. 180215, a counterpressure fan is described which is designed to eliminate the intake of false air from the first section before the preheating zone to the first section in the preheating zone. This device takes up a lot of space and requires a lot of energy. It must continually be moved and installed in each section as the zones move successively forwards in the furnace during the calcining process. When the counterpressure fan is used, an additional section is required in relation to the present invention. This results in major additional costs for the system and also requires more maintenance.

WO 99/08059 describes an inflatable sack for sealing a passage in a flue gas duct in a furnace for baking carbon anodes. The disadvantages of this device are, among other things, that a fan is required to fill the sack with air and to maintain the pressure in the sack. Moreover, such sacks may become leaky and let out air. A consequence of this will be that the sealing quality is reduced.

DE 25 37 133 describes a method for operating section furnaces in which an inflatable air sack may be used as a barrier between the individual sections. It also states that it is possible to use panels or foamed bodies for this purpose, but does not explain how they might be mounted.

GB-A-2 129 918 discloses an open chamber furnace comprising a blow-pipe for the firing of carbonaceous blocks. The furnace comprises a series of chambers which are delimited by lateral walls which have openings at the top, interconnecting the chambers and which may be sealed by insulation dampers. Each chamber is divided into compartments by hollow heating sections. The compartments are connected to the corresponding lateral walls by openings arranged at the top part of their ends. The compartments have openings for communication with one blow pipe enabling combustion air and cooling air to be introduced through said openings or vents. The insulation dampers may either be open or closed in order to include or exclude (respectively) sections of the furnace in the firing process.

One aim of the present invention was to arrive at a method and device for controlling false air intake to the preheating zone in a robust, reliable manner, as well as to increase the efficiency of the closed section ring furnace and reduce the quantity of exhaust gas from the furnace. Moreover, the use of dampers in accordance with the present invention will demonstrate advantageous features in connection with the implementation of a firing advance in which the controlled introduction of a new section in the process can be achieved.

In accordance with the present invention, this is achieved by means of a method and a furnace which involve one or more lowerable and risable dampers being mounted in the head-walls, which may be used to control and shut off the flow of gas in a passage between two sections connected in series. In particular, the dampers may be used to prevent false air from passing through from the first section before the preheating zone to the first section in the preheating zone. The dampers are preferably made of a light material which must withstand a certain temperature (500°C) and mechanical stress. An damper may cover several individual passages.

The present invention will be described in further detail in the following by means of examples and with reference to the attached drawings, where:

- Fig. 1 shows a longitudinal section through three sections in a ring furnace.
- Fig. 2A shows, in perspective, part of a head wall.
- Fig. 2B shows, in perspective, a section of part of a head wall with a lowered damper.
- Fig. 2C shows a section of the head wall with the lowered damper seen from the front.

Fig. 1 shows a longitudinal section through a row of sections in a ring section furnace, in particular three sections K-1, K1 and K2, where K-1 is the first section before the preheating zone and K1 is the first section in the preheating zone. Sections K2 and K1 are closed by section covers 1 and 1'. The damper 4 in the head 2 between sections K-1 and K1 is lowered by means of a connecting device 5 so that it seals the passage between K-1 and K1 and thus prevents false air from passing through. The connecting device 5 may consist of chain, wire, a rod or similar. The connecting device may have markings at its upper end, which makes it possible to read off the extent to which the air damper is closing the passage, i.e. how far down it is. It may also comprise a locking device in order to fix it in a desired position. The passage consists of through openings 14, 15 in the lower part of the head wall 2 which communicate with the adjacent section. The adjustment device 3 in section K1 is connected to a pipe connection (exhaust manifold) (not shown) and draws combustion air through the cooling zone and on through the firing zone, where it is combusted together with the fuel (not shown). The combustion gases created in the firing zone are then drawn through the preheating zone consisting of sections K2, K1 and are transferred to a exhaust gas ring main.

Fig. 2A shows, in perspective, a part 2' of a head wall with gas passage 15 at its lower end.

Fig. 2B shows, in perspective, a part of head wall 2 with a lowered damper 4. The connecting device 5 is fixed to the damper 4 by means of a fixing device 6 and the damper 4 is lowered in a pocket 7 which extends down to the base of the head wall. See also Fig. 2C. The pocket 7 may be part of a firing shaft 8 in the head wall 2. The pocket 7 is at the top equipped with an opening 12 through which the damper 4 may be introduced. Moreover, the opening 12 has a cutout 9 through which the connecting device 5 may be passed, thus ensuring that the damper 4 is lowered in such a way that it is in the correct position against the head wall 2. The opening 12 may be covered by a lid 11 that seals against air leakages from the ambient air and is further provided with means for securing the connecting device in a chosen position. Two blocks 10 are markers in the pocket 7 and function as guides to ensure the damper 4 is in position. When the damper 4 has been lowered, it is kept in place by the pressure difference between section K-1 and section K1, which sucks the damper against the head wall 2 to form a seal and prevents false air leakage from section K-1 to section K1. The blocks 10 prevent the damper 4 to move too far away from the passage(s) and ensure that the vacuum is able to suck it into sealing contact. A lid (not shown) may be used to close the opening to the pocket 7 in the sections which are connected to avoid false air being drawn down through the pocket 7.

The use of the damper 4 leads to the false air intake of the adjustment device 3 from section K-1 to section K1 being controllable, which results in more optimal combustion and the achievement of stable operating conditions in connection with fire advance.

The use of the damper 4 in accordance with the present invention may also enhance the efficiency of the operation of the furnace. In relation to prior art solutions, it will be possible to perform work in section K-1 more or less right up to the fire advance. This means that one section is released in relation to the solution described in, for example, NO 180215. As a consequence of this, the furnace may be constructed with fewer sections. Alternatively, this advantage may be utilised in that blocks may be left to cool for a longer period of time.

The damper 4 is preferably made of aluminium or an aluminium alloy and is preferably < 3 mm thick. The damper 4 should have a certain flexibility so that it can adapt to the contact surface.

It should also be possible to control the dampers so that a desired quantity of false air may pass through if this should be desirable during calcining. The temperature may, in some cases, become so high that it may be advantageous to let in some false air to lower it.

During normal operation of the furnace, the dampers are removed completely from the head walls which form part of the sections used during the calcining process as otherwise they might melt on account of the high temperature. If dampers made from refractory material were used, it would not be necessary to remove the dampers completely. They would just have to be pulled up high enough in the head wall so that they did not disturb the gas transport through the passages. The operating temperature in the head walls may exceed 1400°C and the dampers would therefore have to be made of a refractory material which could withstand this temperature.

All head walls which form part of the furnace should be adapted to receive dampers for closing the passages between the sections. A column/duct system, for example in the lower part of the head wall, is thus arranged in such a way that all gas must pass through the area where the damper(s) is(are) located.

When introducing a new section in connection with a firing advance, damper 4' between section K-1 and section K-2 (only partially shown in Fig. 1) will be used. Moreover, a section cover equivalent to section cover 1' is to be placed on section K-1 (not shown). When section K-1 is introduced as the preheating section, an adjustment device 3' is connected to section cover 1' placed on section K-1, while damper 4 is gradually lifted so that gas is allowed to flow between section K1 and section K-1. In advance, damper 4' is lowered into position so that false air is prevented from flowing from section K-2 to section K-1. At the other end of the process, the last section, which is being cooled, is removed from the circuit (not shown). This method provides good, reliable control of the firing advance. When using prior art solutions, this operation may involve a certain degree of variable gas flow in the sections in the process.

Moreover, the pockets 7 in the head walls 2 and the mounting of the dampers 4 to seal the passages in the head walls may be designed so that the direction of firing in the furnace may be reversed without significant conversion. This means that the dampers 4 in the pockets 7 may be moved in the direction of flow of the gas to seal the passages 14 in the head walls. In practice, they may be moved sideways and cover equivalent passages 15 in the head walls 2 by changing the direction of firing. The advantage of being able to reverse the direction of firing is that variable load on the brick work may be evened out and the life of the furnace may be extended.

Amended Claims II

1. A method for control/closure of gas flow through a passage in a head wall between two sections in a ring furnace for calcining of carbon bodies in which the furnace, during the calcining process, over an area comprising a small number of sections, is divided into a preheating zone, a firing zone and a cooling zone, which are together successively moved forwards in the furnace, where one or more lowerable and risable dampers are placed in said head wall,
characterised in that
the furnace is of a closed section type where its cassette walls have firing gas ducts that connect the space below each section cover with horizontal firing ducts below one floor in each said section and that the passage in relation to said head wall (2) is arranged at a vertical level below the floor of said sections, where the damper (4) is designed to block the gas flow through the passage fully or partially.

2. A method in accordance with claim 1,
characterised in that
the damper (4) is operated by means of a connecting device (5) which is connected to the damper (4) by means of a fixing device (6).

3. A method in accordance with claim 2,
characterised in that
the damper (4) is lowered in a pocket (7) which may be in the firing shaft (8) and which has a cutout (9) at the top through which the connecting device (5) may pass, thus ensuring that the damper (4) is lowered and kept in the correct position along the head wall (2) and brought into contact with the passage (14).

4. A method in accordance with claim 3,
characterised in that
the damper (4) is brought into contact with the passage (15) if the firing direction is changed.

5. A method in accordance with claim 1,
c h a r a c t e r i s e d i n t h a t
the damper (4) is moved into the correct position by means of two blocks (10) which are markers in the pocket (7) and is further kept in sealing contact with the passages by means of the pressure difference between the sections.

6. A method in accordance with claim 1,
c h a r a c t e r i s e d i n t h a t
the damper (4) may be adjusted and controlled so that the false air intake from the first section (K-1) before the preheating zone to the first section (K1) in the preheating zone may be controlled.

7. A method in accordance with claim 1,
c h a r a c t e r i s e d i n t h a t
an adjustment device (3') is connected to a section cover (1') placed on the section (K-1) in connection with the introduction of a section (K-1) as the preheating section and the damper (4) is lifted gradually so that gas is allowed to flow between the sections (K1 and K-1) and the damper (4') is lowered into position in advance so that false air is prevented from flowing from section (K-2) to section (K-1).

8. A ring furnace for calcining carbon bodies provided with at least one controllable/closable passage in a head wall between two sections in said furnace, where the furnace during the calcining process, over an area comprising a small number of sections, is divided into a preheating zone, a firing zone and a cooling zone, which are together successively moved forwards in the furnace, the controllable/closable passage comprises a lowerable and riseable damper (4),
c h a r a c t e r i s e d i n t h a t
the furnace is of a closed section type where its cassette walls have firing gas ducts that connect the space below each section cover with horizontal firing ducts below one floor in each said section and that the passage in relation to said head wall (2) is arranged at a vertical level below the floor of said sections, and where the damper may be operated by means of a connecting device (5) fixed to it.

9. A ring furnace in accordance with claim 8, characterised in that the damper (4), in the lowered position, is pressed against the contact surface by means of the pressure difference between the sections, and two blocks (10) contribute to positioning the damper (4).

10. A ring furnace in accordance with claim 8, characterised in that the damper (4) is preferably made of aluminium or an aluminium alloy.

11. A ring furnace in accordance with claim 8, characterised in that the damper (4) is preferably < 3 mm thick.

12. A ring furnace in accordance with claim 8, characterised in that the connecting device (5) comprises markings at its upper end in order to determine the level of the damper (4) and thus the extent to which the passage is closed.

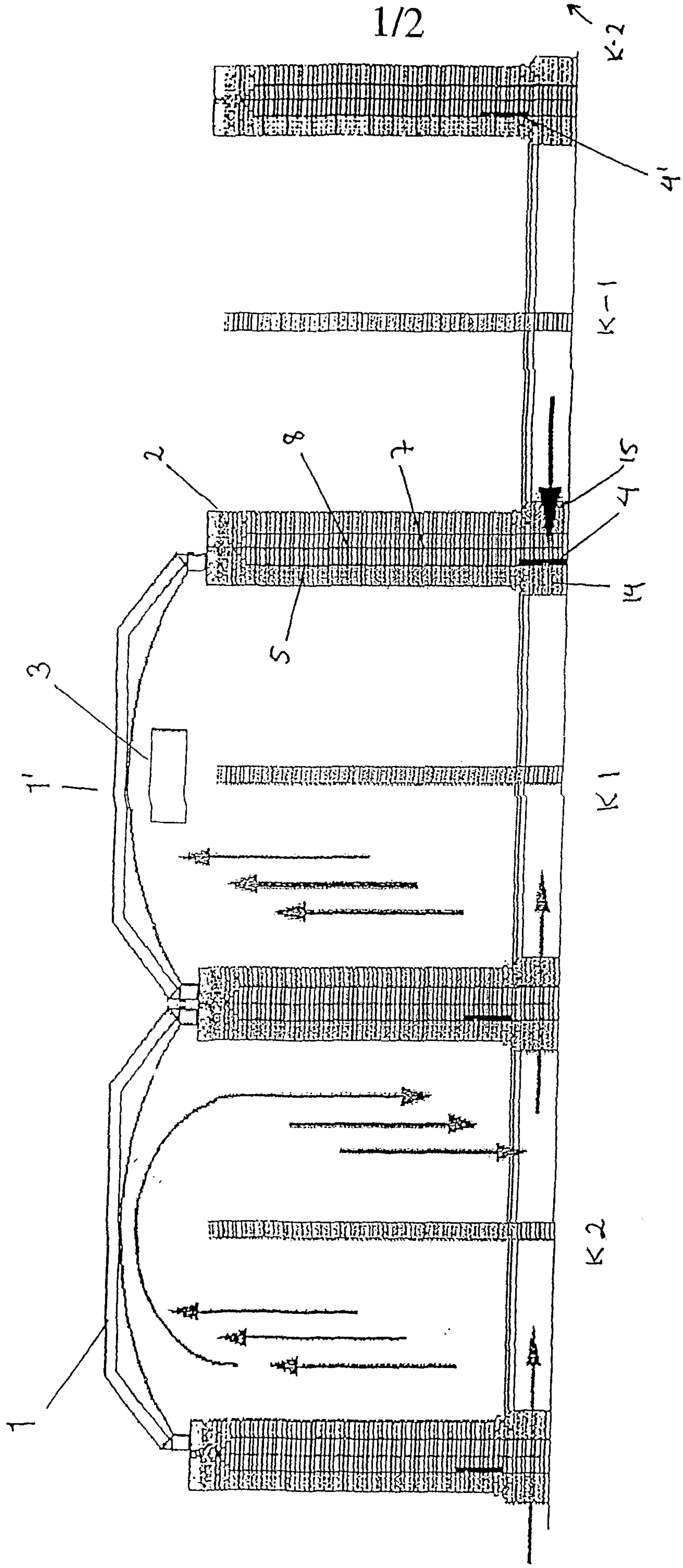

Fig. 1

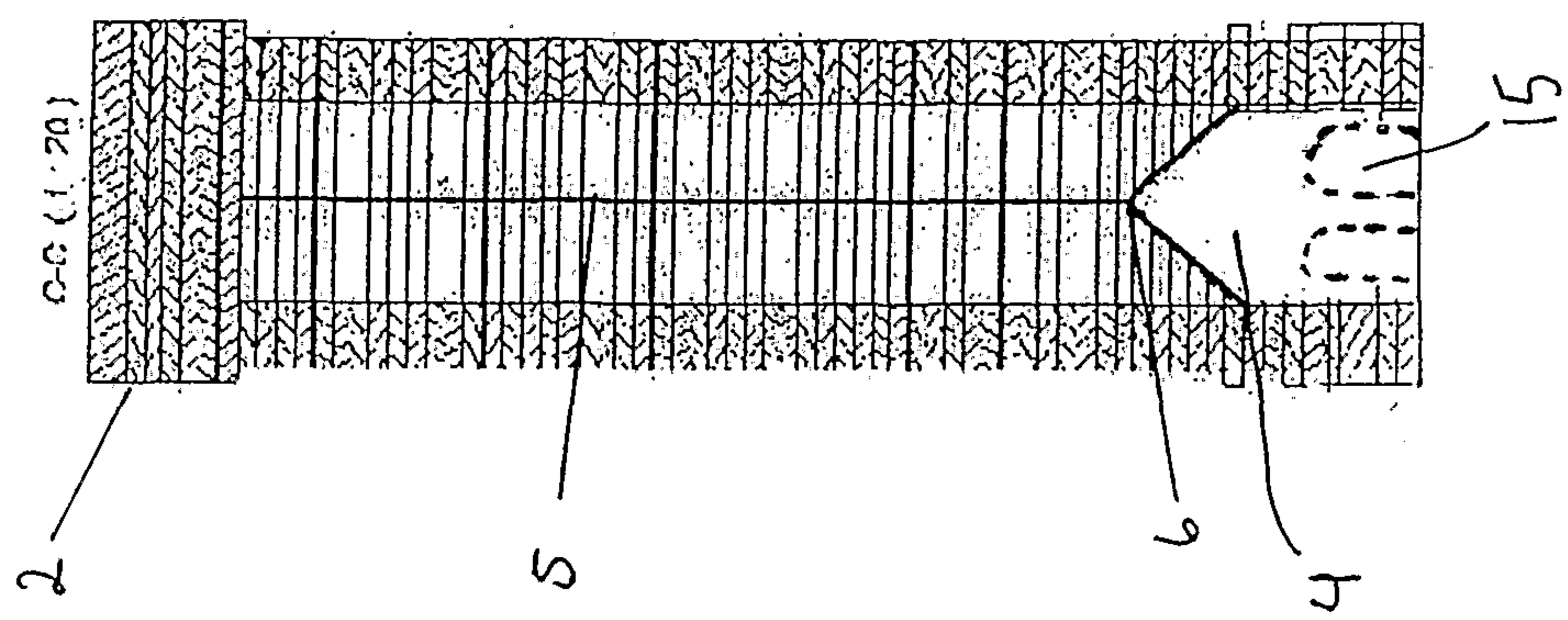

Fig. 2 C

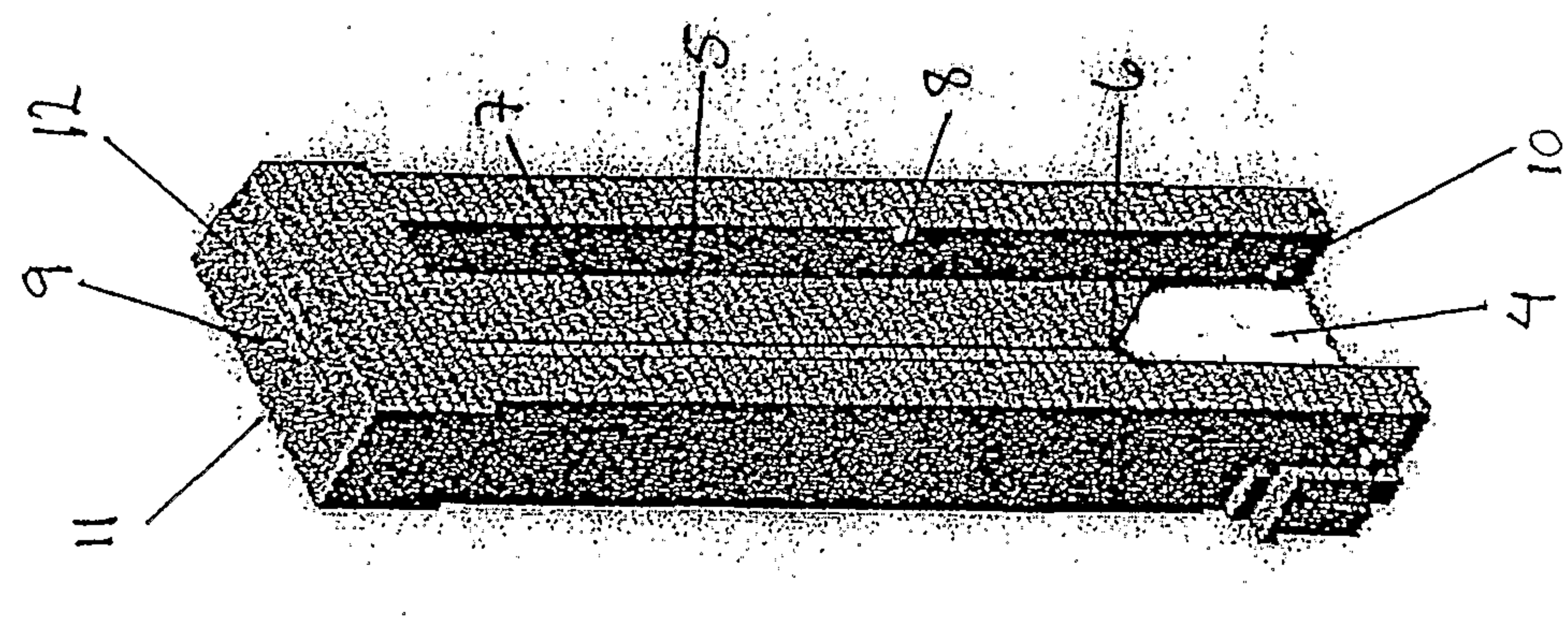

Fig. 2 B

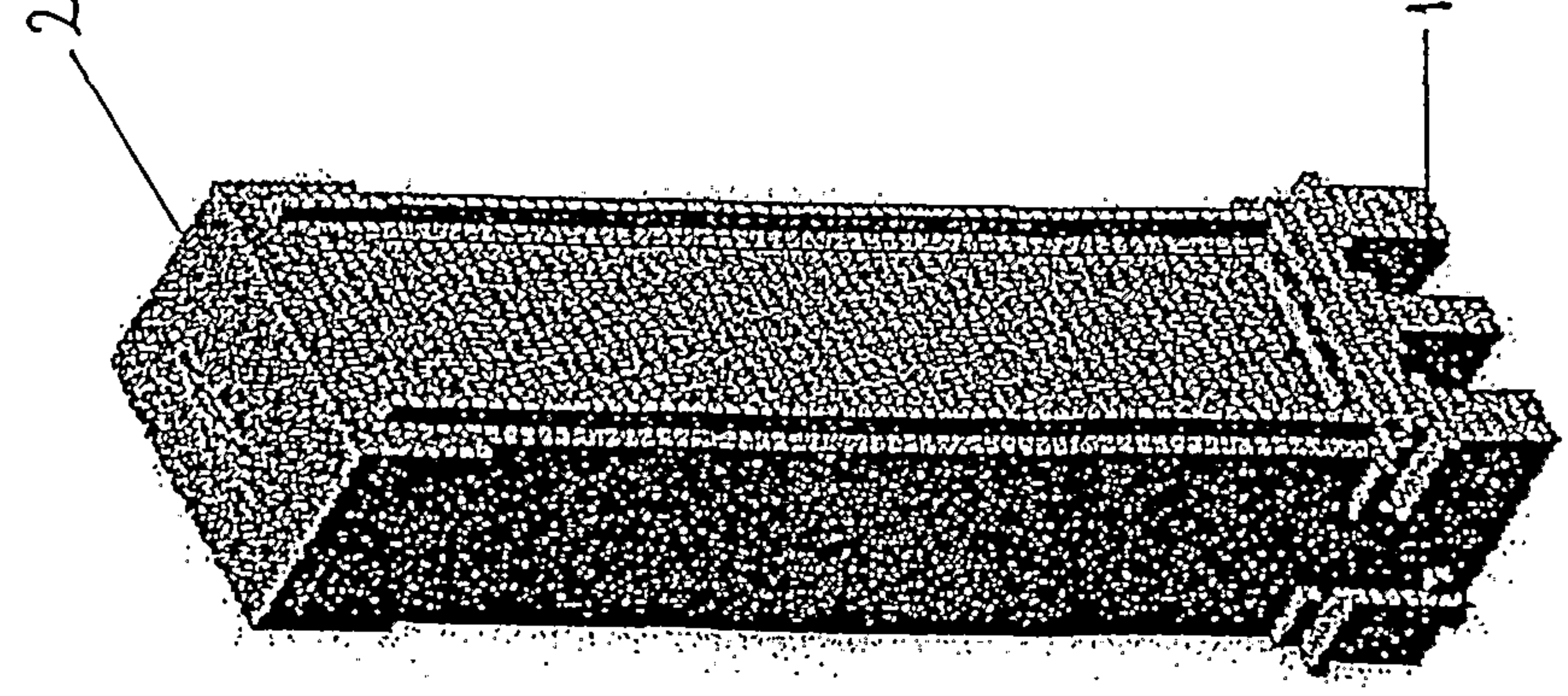

Fig. 2 A


1
1'
3
2
5
8
7
K 2
K 1
14
4
15
K -1
K-2
4'