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(54) **Fireplace**

(57) The invention relates to a fireplace comprising a firebox (1) and a grate (3) provided with apertures (10) for supplying primary air into the firebox (1) comprising a wall assembly (2) provided with at least two horizontally extending arrays of apertures (100, 200, 300) for supplying secondary air into the firebox. In order to be able to burn firewood in the fireplace so that the emissions, in particular carbon monoxide and nitric oxide emissions, simultaneously remain very low, the distance between said at least two arrays of apertures (100, 200, 300) in the vertical direction ranges between 30 and 150 mm, and both arrays of apertures comprise apertures (100a, 100b, 100c and 200a, 200b, 200c) arranged to supply secondary air in a point-like manner substantially in the horizontal direction converging at an angle $\gamma$ = 30 to 80 degrees against one another so that the point-like jets from the apertures hit one another.

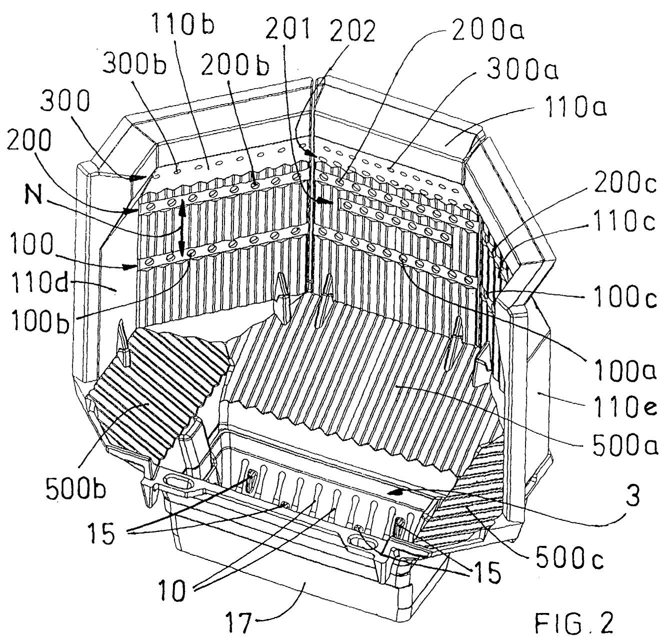


FIG. 2

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## Description

BACKGROUND OF THE INVENTION

**[0001]** The invention relates to a fireplace comprising a firebox and a grate provided with apertures for supplying primary air into the firebox, the firebox comprising a wall assembly provided with at least two horizontally extending arrays of apertures placed in the firebox at different heights for supplying secondary air into the firebox, the arrays of apertures both comprising apertures arranged to supply secondary air in a point-like manner substantially in the horizontal direction converging at an angle $\gamma$ = 30 to 80 degrees against one another.

**[0002]** The invention also relates to a method for burning solid fuel in a fireplace comprising a firebox and a grate provided with apertures for supplying primary air into the firebox, the firebox comprising a wall assembly including a rear part and corner parts provided with at least two horizontally extending arrays of apertures placed in the firebox at different heights for supplying secondary air into the firebox, the arrays of apertures both comprising apertures arranged to supply secondary air in a point-like manner substantially in the horizontal direction converging at an angle $\gamma$ = 30 to 80 degrees against one another.

**[0003]** Fireplaces provided with an arrangement for supplying secondary air into the firebox are previously well known in the art. Supplying secondary air ensures that the combustion gases ignite and burn so that incombustible combustion gases including energy and a lot of carbon monoxide are not discharged from the fireplace.

**[0004]** Publication CH 661 581 A5 discloses a solution in which secondary air is supplied to the firebox from horizontal arrays of apertures, one of which being arranged onto the rear wall and two onto the sidewalls of the firebox, in which case they spray at a right angle against one another.

**[0005]** Patent publication US 4026247 discloses a furnace comprising horizontal arrays of apertures arranged above the grate for supplying air into a combustion chamber. The aperture arrangement presented in the publication for supplying air does not enable controlled slow burning, in which hydrocarbon and nitrogen emissions are simultaneously kept low.

**[0006]** Publication EP 0 754 907 A2 discloses a method for controlling burning in a furnace. Air is supplied into a combustion chamber above the grate using oppositely directed air nozzles. The arrangement of the air nozzles does not enable controlled slow burning, where both hydrocarbon and nitrogen emissions are simultaneously kept low.

**[0007]** Even though prior art solutions have been able to reduce carbon monoxide emissions considerably; the solutions have not been able to simultaneously reduce nitric oxide emissions efficiently. This is due to the fact that almost no turbulence is formed in prior art fireplaces, instead the combustion gases move straight upwards in the firebox, whereby the delay of the combustion gases in the firebox is short. Prior art fireplaces are therefore not capable of supplying secondary air to provide efficient combustion, where carbon monoxide and nitric oxides simultaneously controlledly remain low.

BRIEF DESCRIPTION OF THE INVENTION

**[0008]** It is an object of the invention to avoid the above drawback. In order to achieve this, the fireplace according to the invention is characterized in that

**[0009]** the wall assembly comprises a plate-like rear part placed in the rear part of the firebox and plate-like corner parts placed in the corner parts of the firebox,

**[0010]** the arrays of apertures are formed into the rear part and corner parts of the wall assembly so that the mutual distance between the arrays of apertures in the vertical direction ranges from 30 to 150 mm,

**[0011]** the surface area of the apertures in the arrays of apertures formed in the rear part of the wall assembly is larger than the surface area of the apertures in the arrays of apertures formed in each corner part of the firebox,

**[0012]** the rear part and corner parts of the wall assembly are arranged at a distance from a stone structure surrounding the firebox of the fireplace so that at least one buffering space is formed between the stone structure and the wall assembly for supplying an air impulse into the arrays of apertures, and that

**[0013]** some of the apertures in the rear part of the wall assembly are arranged to spray secondary air towards the secondary air being sprayed from the apertures of the corner parts in the wall assembly so that the jets hit one another.

**[0014]** The arrangement provides the firebox with two plate-like mixing layers, in which secondary air and pyrolysis gases are mixed by rotating turbulently. Because of the above, the firebox may be referred to as a rotation chamber. The gas flows are allowed to rotate in the rotation chamber, in which case the gases remain considerably longer in the firebox, and consequently the combustion result is better than in prior art fireboxes. The rotations of the gas flows as well as the delay in the firebox prevent the temperature from rising to such a level that large amounts of nitric oxide are created. In view of the above, hydrocarbon and nitrogen emissions are both simultaneously maintained at a modest level.

**[0015]** Since the surface area of the arrays of apertures formed in the rear part of the wall assembly is larger than the surface area of the arrays of apertures formed in one corner part of the firebox, it is ensured that air can be supplied to the front part of the firebox, or at least close to the front part of the firebox, said rotation mixing is achieved even though the firewood were vertically set into the firebox. In the latter case, the force of the airflow is sufficient to turn/rotate around the firewood placed in the upright position and bringing some of the pyrolysis gases into a horizontal mixing pattern supported by the corner walls and/or by air vortexes supplied from the sidewalls.

**[0016]** No apertures or the like should be placed between the arrays of apertures that would prevent the formation of the mixing layers. Consequently the area between the arrays of apertures is completely, or substantially, free of apertures.

**[0017]** The fireplace is easy to assemble when the arrays of apertures are formed in the plate-like parts. In addition, the plate-like removable parts are substantially easy to service, for instance to clean, in comparison with if the arrays of apertures were formed into a thick fixed stone structure. The plates are also easy to renew, if such a need would arise owing to wear. Furthermore, pressure drops in the short apertures in the plate-like parts are small compared with if the apertures were long, as they would be if they were formed into a thick wall. Since at least one buffering space is provided between the plate-like parts and the stone structure, where the air pressure exceeds the air pressure inside the firebox, the apertures provide adequately powerful air jets even if the fireplace operates merely by means of natural draw.

**[0018]** The preferred embodiments of the fireplace are disclosed in the appended claims 2 to 9.

**[0019]** The method according to the invention is characterized in that during the combustion of combustible matter an air impulse is supplied from at least one buffering space formed between the wall assembly and a stone structure surrounding the firebox to the arrays of apertures, and secondary air is supplied to the firebox of the fireplace through the arrays of apertures so that some of the apertures in the rear part of the wall assembly spray secondary air towards the secondary air being sprayed from the apertures in the corner parts of the wall assembly so that the jets hit one another, whereby air is also supplied in such a manner that more air is supplied from the rear wall of the wall assembly than from the apertures of either corner plate in order to provide the firebox with two plate-like horizontal mixing layers, in which secondary air and pyrolysis gas are mixed by rotating turbulently, thus slowing down the combustion process in the firebox.

**[0020]** The most considerable advantages the fireplace and the method according to the invention provide include allowing horizontal mixing layers to be formed into the firebox, in which secondary air and pyrolysis gases are mixed by rotating turbulently, thus increasing the time the combustible gases remain in the firebox, thereby enabling the efficient and low-emission combustion process of firewood. In addition to the carbon monoxide emissions, nitric oxide emissions are simultaneously kept low. Particularly, if the fireplace comprises the grate described below, combustion may be very efficient and clean throughout the entire combustion process, i.e. during the initial stage, "normal" stage and the final stage of the combustion. The same charge weight results in a twice as clean combustion outcome compared with the prior art systems. The solution of the invention is applicable to be used in all main fireplace categories. Thus, the invention may similarly be applied in large heat storing fireplaces and in small stoves.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]** In the following, the invention will be described in greater detail by means of the preferred embodiments with reference to the accompanying drawing, in which

Figure 1 is a general view showing a fireplace according to the invention,
Figure 2 shows in perspective a wall assembly of a firebox in the fireplace shown in Figure 1,
Figure 3 shows a front view of the wall assembly shown in Figure 2,
Figure 4 shows the wall assembly of a grate shown in Figure 3 along cutting line IV - IV in Figure 3,
Figure 5 illustrates the wall assembly shown in Figure 3 along cutting line V - V in Figure 3,
Figure 6 illustrates air jets obtained by means of the wall assembly shown in Figures 2 to 5 from the view angle of Figure 5,
Figure 7 illustrates an alternative wall assembly for Figures 5 and 6 and the air jets obtained by means thereof,
Figure 8 illustrates mixing layers obtained by means of the wall assembly of the firebox in Figures 2 to 5 from the view angle of Figure 3, and
Figures 9 and 10 illustrate gas rotations obtained by means of the wall assembly of the firebox in Figures 2 to 5 from the view angle of Figure 6.

## DETAILED DESCRIPTION OF THE INVENTION

**[0022]** Figure 1 shows a fireplace that generally comprises a firebox indicated with reference numeral 1. A wall assembly of the firebox, the height of which typically ranges between 40 and 80 cm, is indicated with reference numeral 2 and a grate at the bottom of the firebox is indicated with reference numeral 3. Reference numeral 30 indicates an air control apparatus 30 used for directing air partly through the grate 3 and partly via arrays of openings or apertures 100 in the wall assembly 2 of the firebox. Air supplied through the grate 3 is referred to as primary air and air supplied through the wall assembly 2 is referred to as secondary air. At the beginning of ignition, the ratio between primary air and secondary air is larger than if the fireplace is already heated.

**[0023]** Figures 2 to 5 explain in more detail how the arrays of apertures are formed into the wall assembly of the fireplace. Figures 2, 4 and 5 also describe the structure of the grate 3.

**[0024]** Figures 2 to 6 show that the walls of the firebox comprise perforated plates 110a, 110b and 110c. The sidewalls also comprise plates 110d and 110e without apertures. The plates 110d and 110e could alternatively be provided with apertures. The plate 110a is a rear plate, the plates 110b and 110c are corner plates, and the plates 110d and 110e are side plates. The plates 110b and 110c are symmetrical in relation to the plate 110a. Likewise, the plates 110d and 110e are symmetrical regarding the plate 110a.

**[0025]** The plates 110a, 110b and 110c comprise a first array of openings or apertures 100, a second array of apertures 200 and a third array of apertures 300. The arrays of apertures 100, 200, 300 are substantially horizontal and comprise a plurality of apertures 100b, 100a, 100c, 200b, 200a, 200c, and 300b, 300a, 300c respectively. In the firebox, the lowest arrays of apertures 100, 200 are placed below the fireplace throat 220 and the highest array of apertures 300 is placed at the lower end of the fireplace throat. It is possible that the throat comprises one or more arrays of apertures 400, 600 placed above the array of apertures 300, cf. Figure 1. It is also possible that one or more arrays of apertures are placed above the throat.

**[0026]** The arrays of apertures 100, 200 and 300 are arranged to supply air substantially in the horizontal direction to places in the firebox, which are located considerably above the upper end 4 of the grate and in such a manner that the air jets starting from the corner plates 110b and 110c converge with the air jets starting from the rear plate 110a. The air jets provided from the corner plates 110b, 110c are at an angle $\gamma$, which recommendably ranges between 30 and 80 degrees, in relation to the jets provided from the rear plate 110a, so that the jets at least partly hit one another, cf. Figure 6.

**[0027]** An additional array of apertures 201, 202 is formed on the rear plate 110a, below and above the array of apertures 200. The additional arrays of apertures 201 and 202 strengthen the airflow from the rear plate 110a and assist the rotation of the gases described below in the firebox 1. Consequently, the rear plate 110a is provided with more apertures than the corner plate 110b or 110c and the total surface area of the apertures in the rear plate is larger than the total surface area of the apertures in the corner plate 110b or 110c. Alternatively, the required amount of air supplied from the rear plate 110a can be obtained by providing the rear plate with larger apertures than the corner plates 110b, 110c. The apertures in the plates 110a, 110b, 110c are symmetrically placed in respect of the vertical plane, which bisects the firebox 1.

**[0028]** The diameter of the apertures in the arrays of apertures 100, 200, 201, 202, 300 is recommended to be 10 to 12 mm. If the diameter is too small, the strength of the air jets remains too low. The apertures may comprise a wall, on which a thread is formed in order to achieve a rotational motion for the air supplied from the aperture.

**[0029]** The mutual distance N between the arrays of apertures 100 and 200 preferably ranges between 30 and 150 mm, and more preferably between 30 and 100 mm, cf. Figure 8. Most preferably, the distance N ranges between 30 and 50 mm.

**[0030]** The apertures in the arrays of apertures 100, 200, 201, 202 and 300 are arranged to supply secondary air into the firebox in a point-like manner, cf. the arrows in Figure 6. The arrows of different lengths in Figure 6 illustrate that the rear plate 110 is arranged to supply more air into the firebox 1 than the corner plates 110b and 110c (and side plates 110d, 110e, if they were provided with apertures). This is important in order to achieve the desired low-emission combustion process in the firebox.

**[0031]** The air jets supplied from the described arrays of apertures 100, 200, 201, 202 and 300 provide three thin plate-like layers I, II and III placed at a distance from one another in the vertical direction, also referred to as fraction layers, in which air and combustion gases are mixed, cf. Figure 8. The thickness of each layer I, II and III preferably ranges between 10 and 30 mm.

**[0032]** Mixing of secondary air and combustion gases occurs in fraction layers I, II and III so that the gases rotate as illustrated in Figures 9 and 10. When the gases rotate, the flame rotates about its axis and a refracting motion (fraction motion) in the direction of the grate is achieved. In Figure 9, the arrows illustrate the rotation of the gases when the firewood to be burnt is placed horizontally on the grate 3. In Figure 10, the arrows illustrate the rotation of the gases when firewood 180 is placed on the grate 3 vertically. A dashed line indicates the firewood 180 in the Figures. Other fixed combustible matter may also be burnt in the fireplace instead of firewood, for instance pellets.

**[0033]** In Figure 9, the starting end (i.e. the wide end) of the arrows is placed at the edges of the grate. The starting ends of the wide arrows indicate the air supplied from the ignition nozzles as well as the ignited gases. The mixture of air and gases flows obliquely upward towards the corresponding corner plates 110b, 110c, and the air supplied therefrom is mixed with the above-mentioned gases, also illustrated by the wide arrows. The gases continue substantially in the horizontal direction towards the rear wall 110a, but turn substantially in the horizontal plane towards the grate owing to the air jets arriving from the back (narrow arrows), as the wide arrows indicate. The narrow end of the wide arrows comprises all the above-mentioned gases.

**[0034]** In Figure 10, mixing occurs in front of the firewood, i.e. in the space between the firewood 180 and the fireplace door. For the sake of simplicity, Figure 12 only shows two arrows that illustrate the flow of gases in the horizontal direction. In addition to the air jets supplied from the rear plate 110a the arrows include air jets supplied from the corner plates 110b, 110c and naturally the combustion gases.

**[0035]** The rotation chamber provides such a special feature that horizontal turbulence layers are formed in the rear part of the box irrespective of whether the firewood is placed vertically or horizontally. The achieved rotational gas flows allow the gases to remain considerably longer in the firebox, and the proportional delay time of the combustion gases increases in comparison to a conventional firebox. The temperature in the rotation chamber does not increase to a noxiously high level regarding the nitrogen emission, and the combustion outcome is therefore better than in prior art fireboxes. In conventional fireboxes, the temperature easily and uncontrollably becomes so high that large amounts of nitric oxides are formed. In the rotation chamber, hydrocarbon and nitrogen emissions are both simultaneously kept at a fairly low level.

**[0036]** In the fireplace shown in the Figures, air and gas are mixed in the horizontal steps rotating "in layers" within each other.

**[0037]** Figure 7 shows an alternative to the wall assembly shown in Figure 5 and the air jets achieved thereby. Corresponding reference numerals have been used for the parts corresponding to those shown in Figure 6. For the sake of simplicity, the air jets starting from the end of the grate have not been indicated. Figure 7 shows an arrangement, in which the side plates 110d', 110e' are also provided with arrays of apertures substantially at the same height as the apertures 100a' to 100c', 200a' to 200c' and 300a' to 300c' respectively. In addition, the wall assembly in Figure 7 comprises facial corner plates 110f' and 110g' provided with apertures 100f', 200f', 300f' and 100e', 200e', 300e' respectively, which are substantially placed at the same height with the apertures 100a' to 100c', 200a' to 200c' and 300a' to 300c' respectively. The apertures 100f', 200f', 300f' and 100g', 200g', 300g' are arranged to supply air obliquely inwards.

**[0038]** In the fireplace shown in Figures 1 to 10, air and gas are mixed in the horizontal steps rotating "in layers" within each other. The required air impulse for the apertures in the arrays of apertures 100, 200, 201, 202, 300 and from there to the firebox 1 is obtained using buffering spaces 152, 153, cf. Figures 5 and 6. The buffering spaces 152, 153 that operate as natural pumps towards the firebox 1, while the fireplace is attached to a flue, are placed between the corner plates 110b and 110c and the corners of the stone structure in the firebox. In a fireplace that functions by means of natural draw, the air pressure in the buffering spaces 152, 153 exceeds the air pressure on the grate side surfaces of the rear and corner plates. The air control apparatus 30 directs air via the apertures 10 travelling through the grate 3 and also passed the grate through passages/gaps 151, 154 and the buffering spaces 152, 153 into the firebox through the openings in the arrays of apertures 100, 200, 201, 202, 300 (cf. Figures 1, 5 and 6). Alternatively, the required overpressure and air impulse can be achieved using a fan. The last-mentioned solution is much more complicated and expensive to implement.

**[0039]** The details concerning the size and location of the apertures in the wall assembly 2 may differ from what has been presented. It should be noted that it is impossible in practice to provide general values for the size (diameter and length), number and location of the apertures in the plates of the "rotation chamber", since said parameters affect one another. Considering the solutions described herein, a person skilled in the art may implement, however, the invention as well as the rotation and mixing of the gases in the firebox without requiring excessive experimentation.

**[0040]** Figure 2 also shows such a significant feature of the firebox, according to which grooved surfaces 500a, 500b, 500c are found between the wall assembly and the grate. The grooves on the grooved surfaces 500a, 500b, and 500c enable to supply air more efficiently from the grate 3 towards the plates 110a to 110e.

**[0041]** The above wall assembly is particularly applicable to be used with the grate 3 shown in Figures 2, 4 and 5, since the emission created during combustion are thus kept especially low. In view of the above, the structure of the grate shown in Figures 1, 4 and 5 is also described below.

**[0042]** The grate 3 shown in Figure 1 comprises an upper end 4, a lower end 5 and a rectangular wall construction including two longer walls 6 and 7 and two shorter walls 8 and 9.

**[0043]** The walls 6, 7 are provided with an array of elongated apertures 10. The number of apertures 10 in each wall 6, 7 is recommended to be 10 to 30. If the number of apertures 10 remains below ten, the grate will not operate appropriately.

**[0044]** The apertures 10 are elongated and the surface area thereof close to the lower end 5 of the grate is larger than the surface area thereof close to the upper end 4 of the grate.

**[0045]** Figure 5 shows that the main direction of the apertures 10 is the same as that of an imaginary line L on the wall 6 extending perpendicularly in relation to the level defined by the upper end 4 of the grate. The main direction of the apertures 10 may vary from what is shown in that it is placed at an acute angle below 40 degrees in relation to the line L. Preferably the angle is below 30 degrees. If the angle exceeds 40 degrees, the apertures 10 are not operating appropriately in view of the object of the invention.

**[0046]** Figure 5 also shows the recommendable wedge-shaped form of the apertures 10. The apertures 10 taper from the bottom to the top so that they provide the grate 3 with logarithmic air flow.

**[0047]** The upper end of the apertures 10 comprises a nozzle opening 11 with a diameter that exceeds the width of the apertures immediately below the nozzle opening. The diameter of the nozzle opening 11 preferably ranges between 5 and 15 mm.

**[0048]** As Figure 4 shows, the walls 6 and 7 of the grate are at an angle $\alpha$ = approximately 70 degrees in respect of one another. The angle $\alpha$ preferably ranges between 50 and 90 degrees and more preferably between 60 and 80 degrees. If the angle $\alpha$ is too large, the walls 6, 7 will not efficiently direct the partly but also completely burnt material on the grate downward towards the lower end of the grate. If the angle $\alpha$ is too small, the plane surface area in the upper end and the volume of the grate 3 remain very small, if the grate is not made very deep or very large. A deep and/or large grate is inappropriate in view of the size of the fireplace and therefore impossible to implement in practice.

**[0049]** Reference numeral 15 indicates projections formed on the inner surfaces of the walls. The number of projections 15 is at least two on both opposite walls 6, 7. The projections 15 are arranged approximately in the middle of the upper and lower end of the grate. The projections 15 operate as supports preventing the firewood placed horizontally on the grate from falling to a grate space 16 beneath the projections, referred to as an ignition space, into which the ignition material is placed before ignition, cf. Figure 4. The projections 15 also operate as turbulence means causing turbulence to the combustion air. The turbulence allows the air to be appropriately mixed with the pyrolysis gases, which in turn improves the combustion process in view of the purity of the combustion. The number and precise location of the projections 15 may vary. Instead of projections, thresholds or the like can also be employed. A combined term used here for projections, thresholds or the like functioning as support means and turbulence means is support/turbulence means.

**[0050]** Figure 4 also shows that the shorter walls 8, 9 of the grate are provided with apertures 12. The object of the apertures 12, the number of which may be one or more, is to direct combustion air above the upper end 4 of the grate. The apertures 12 direct combustion air to the inner surface of the upper half of the grate wall 9, on which a trough-like guiding means 14 is formed. The guiding means 14 ends at a nozzle opening 19, located above the upper end 4 of the grate at a distance ranging from 10 to 50 mm, preferably from 20 to 30 mm, from the level defined by the upper end 4 of the grate. The nozzle opening 19 forms an ignition nozzle, which ignites the combustion gases on the upper surface of the grate. If the nozzle opening 19 is placed too high above the upper end of the grate, air is not directed close enough to the combustion gases, which will therefore not ignite. If the nozzle opening 19 is placed too close to the upper surface 4 of the grate, the nozzle opening is not capable of directing air above the combustion gases, if the grate is filled with material. The opposite wall 8 of the grate 3 comprises similar apertures and guiding means 13.

**[0051]** The grate 3 is typically made of cast iron. The grate 3 is placed into a frame 17 typically also made of cast iron, cf. Figures 2 to 4. An ash bin 18 (cf. Figure 1) is placed beneath the frame 17. Air control means 30 are placed between the ash bin 18 and the grate 3 that allow directing air through the apertures 10 travelling through the grate 3 and also passed the grate 3 to the firebox via passages/gaps 151, 154 and buffering spaces 152, 153 through the apertures 100, 200, 300 in the arrays of apertures.

**[0052]** The grate may have a different form than a rectangle; the precise location of the apertures on the grate may deviate from what is shown; the shape of the ignition nozzles may deviate; ignition nozzles are not even necessarily required, although they significantly improve the operation of the grate.

**[0053]** It should be noted that the details of the invention may be implemented in various ways within the scope of the appended claims and differently than shown in the Figures. Thus, for instance, the number of arrays of apertures may deviate from what is shown in the Figures, as well as the shape of the wall assembly.

## Claims

**1.** A fireplace comprising a firebox (1) and a grate (3) provided with apertures (10) for supplying primary air into the firebox, the firebox (1) comprising a wall assembly (2) provided with at least two horizontally extending arrays of apertures (100, 200, 300) placed in the firebox at different heights for supplying secondary air into the firebox, the arrays of apertures both comprising apertures (100a, 100b, 100c and 200a, 200b, 200c; 100a', 100b', 100c', 100d', 100e' and 200a', 200b', 200c' 200d', 200e') arranged to supply secondary air in a point-like manner substantially in the horizontal direction converging at an angle $\gamma$ = 30 to 80 degrees against one another, **characterized in that** the wall assembly (2) comprises a plate-like rear part (110a; 110a') placed in the rear part of the firebox and plate-like corner parts (110b, 110c, 110b', 110c') placed in the corner parts of the firebox,

the arrays of apertures (100, 200, 300) are formed into the rear part (110a, 110a') and corner parts (110a, 110b, 110c; 110a') of the wall assembly so that the mutual distance between the arrays of apertures in the vertical direction ranges from 30 to 150 mm,

the surface area of the apertures (100a, 200a, 300a; 100a', 200a', 300a') in the arrays of apertures (100, 200, 201, 202, 300) formed in the rear part (110a) of the wall assembly is larger than the surface area of the apertures (100b, 200b, 300b or 100c, 200c, 300c; 100b', 200b', 300b' or 100c', 200c', 300c') in the arrays of apertures (100, 200, 300) formed in each corner part (110b or 110c; 110b' or 110c') of the firebox,

the rear part (110a, 110a') and corner parts (110b, 110c; 110b', 110c', 110d', 110e') of the wall assembly are arranged at a distance from a stone structure (150) surrounding the firebox of the fireplace so that at least one buffering space (152, 153) is formed between the stone structure and the wall assembly for supplying an air impulse into the arrays of apertures (100, 200, 300), and that

some of the apertures (100a, 200a, 300a; 100a', 200a', 300a') in the rear part (110a) of the wall assembly are arranged to spray secondary air towards the secondary air being sprayed from the apertures (100b, 200b, 300b or 100c, 200c, 300c; 100b', 200b', 300b' or 100c', 200c', 300c') of the corner parts (110b or 110c; 110b' or 110c') in the wall assembly so that the jets hit one another.

**2.** A fireplace as claimed in claim 1, **characterized in that** the wall assembly comprises a rear part (110a, 110a') and corner parts (110b, 110c, 110b', 110c') and that the rear part (110a, 110a') comprises two arrays of apertures (100a and 200b; 100a', 200a'), and both corner parts (110b, 110c, 110b', 110c') comprise arrays of apertures (100b and 100c and 200a and 200c respectively; 100b' and 100c' and 200a' and 200c' respectively) arranged substantially at the same height as the arrays of apertures in the rear part.

**3.** A fireplace as claimed in claim 2, **characterized in that** both side parts (110d', 110e') of the wall assembly are provided with two arrays of apertures (100d' and 200d') substantially at the same height as the arrays of apertures (100a', 200a') in the rear part (110a').

**4.** A fireplace as claimed in claim 1, **characterized in that** an area substantially free of apertures exists between said at least two arrays of apertures (100 and 200).

**5.** A fireplace as claimed in claim 1, **characterized in that** the width (N) of the area ranges between 30 and 100 mm.

**6.** A fireplace as claimed in claim 1, **characterized in that** said at least two arrays of apertures (100, 200) are arranged to provide the firebox (1) with two plate-like mixing layers (II, III) for mixing secondary air and pyrolysis gas, and the thickness (K) of the mixing layers ranges between 10 and 30 mm.

**7.** A fireplace as claimed in claim 1, **characterized in that** the diameter of the apertures in the arrays of apertures (100, 200, 300) ranges between 8 and 12 mm.

**8.** A fireplace as claimed in claim 1, **characterized in that** the horizontal arrays of apertures (400, 600) are also arranged into the fireplace throat (220).

**9.** A fireplace as claimed in any one of the preceding claims, **characterized by** comprising a firebox (1) and a trough-shaped grate (3) including an upper end (4) and a lower end (5) and a wall construction (6 to 9) comprising walls (6, 7) at an acute angle ($\alpha$) in relation to one another, the walls being provided with elongated apertures (10) for supplying combustion air through the grate, the main direction of the apertures being at a 40 degree angle at the most in respect of an imaginary line (L) on the wall (6, 7), where the apertures are formed, said line extending at a right angle in relation to a level defined by the upper end (4) of the grate, whereby the surface area of the apertures (10) close to the lower end (5) of the grate is larger than the surface area close to the upper end (4) of the grate.

**10.** A method for burning solid fuel in a fireplace comprising a firebox (1) and a grate (3) provided with apertures (10) for supplying primary air into the firebox, the firebox (1) comprising a wall assembly (2) including a rear part (110a) and corner parts (110a, 110b, 110c; 110a') and provided with at least two horizontally extending arrays of apertures (100, 200, 300) placed in the firebox at different heights for supplying secondary air into the firebox, the arrays of apertures both comprising apertures (100a, 100b, 100c and 200a, 200b, 200c; 100a', 100b', 100c', 100d', 100e' and 200a', 200b', 200c' 200d', 200e') arranged to supply secondary air in a point-like manner substantially in the horizontal direction converging at an angle $\gamma$ = 30 to 80 degrees against one another, **characterized in that** during the combustion of combustible matter an air impulse is supplied from at least one buffering space (152, 153) formed between the wall assembly (2) and a stone structure (150) surrounding the firebox (1) to the arrays of apertures (100, 200, 300), and secondary air is supplied to the firebox (1) of the fireplace through the arrays of apertures so that some of the apertures (100a, 200a, 300a; 100a', 200a', 300a') in the rear part (110a) of the wall assembly (2) spray secondary air towards the secondary air being sprayed from the apertures (100b, 200b, 300b or 100c, 200c, 300c; 100b', 200b', 300b' or 100c', 200c', 300c') in the corner parts (110b or 110c; 110b' or 110c') of the wall assembly so that the jets hit one another, whereby air is also supplied in such a manner that more air is supplied from the rear wall of the wall assembly than from the apertures (100b, 200b, 300b or 100c, 200c, 300c; 100b', 200b', 300b' or 100c', 200c', 300c') of either corner plate (110b or 110c; 110b' or 110c') in order to provide the firebox with two plate-like horizontal mixing layers, in which secondary air and pyrolysis gas are mixed by rotating turbulently, thus slowing down the combustion process in the firebox.

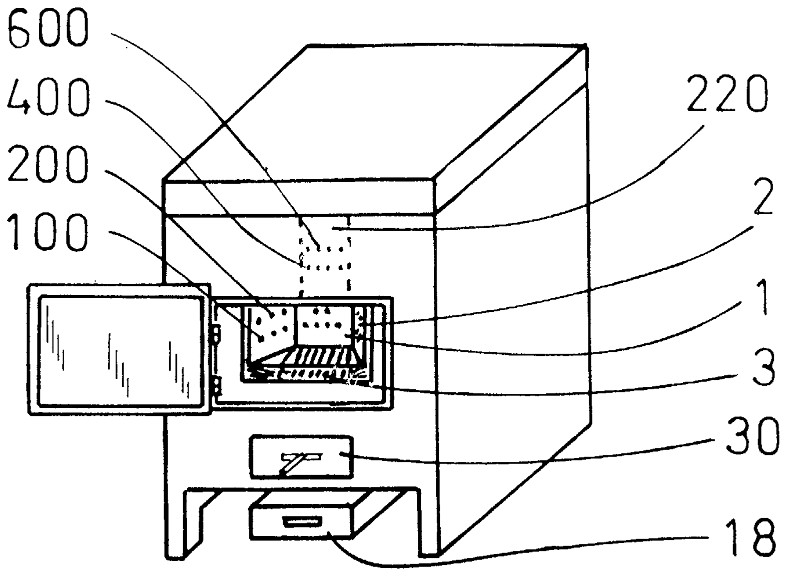
600
400
200
100
220
2
1
3
30
18

FIG. 1

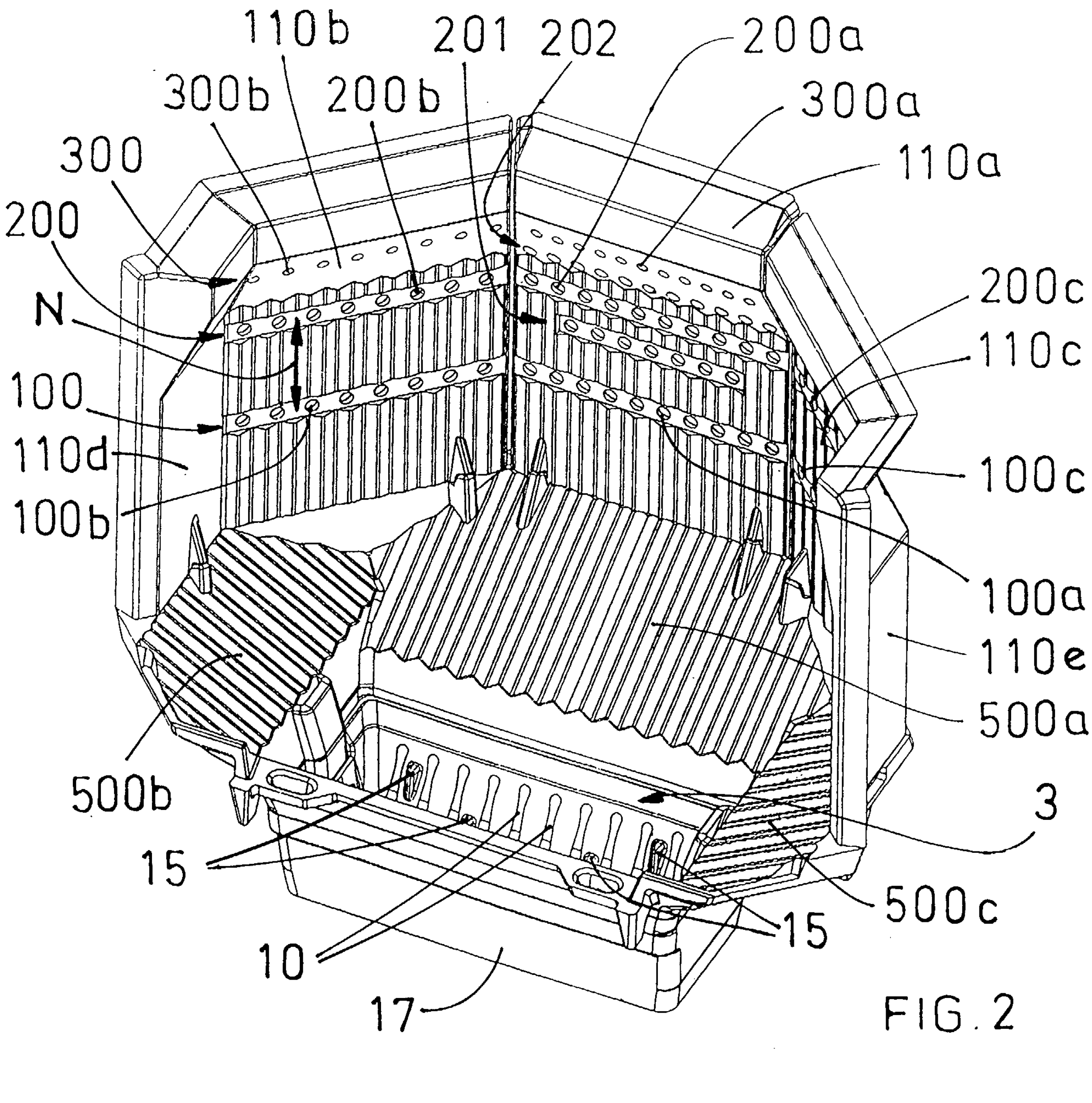
110b
201
202
200a
300b
200b
300a
300
110a
200
200c
N
110c
100
110d
100c
100b
100a
110e
500a
500b
3
15
500c
15
10
17

FIG. 2

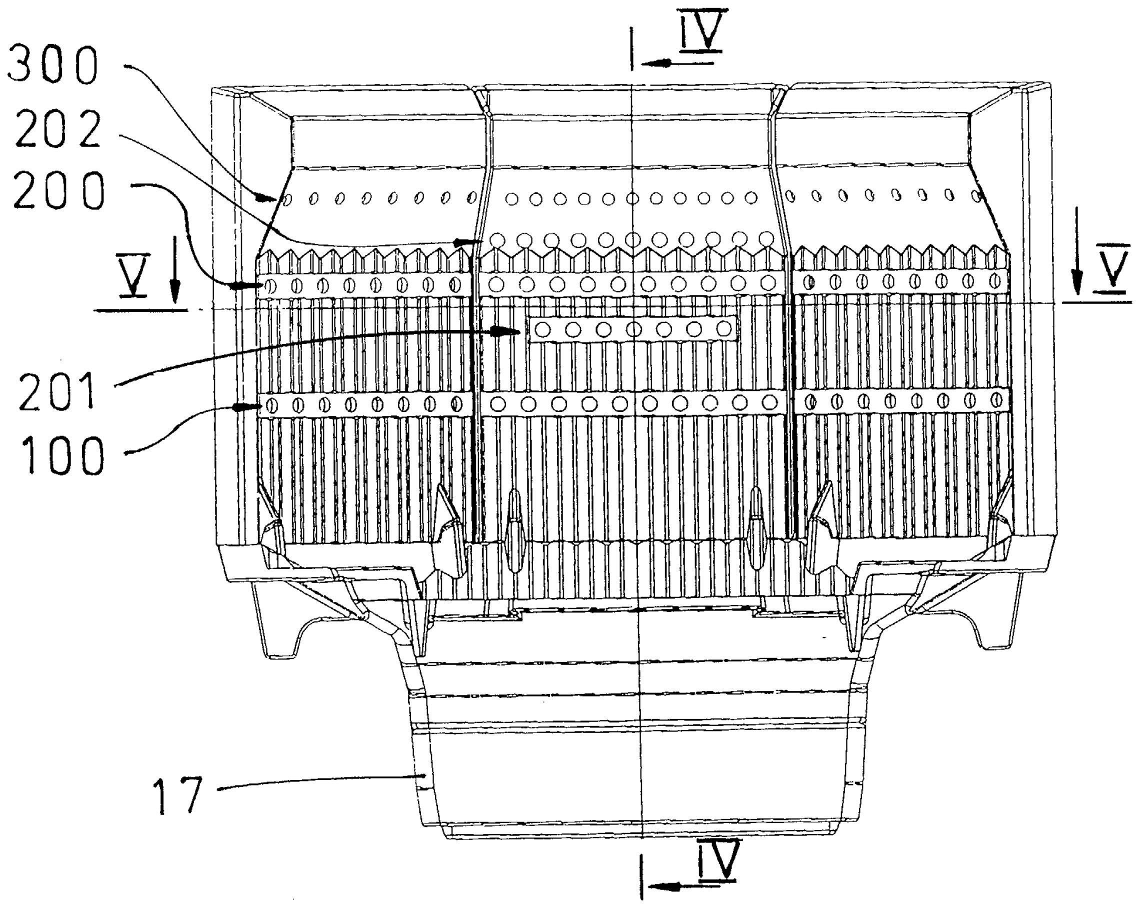


FIG. 3

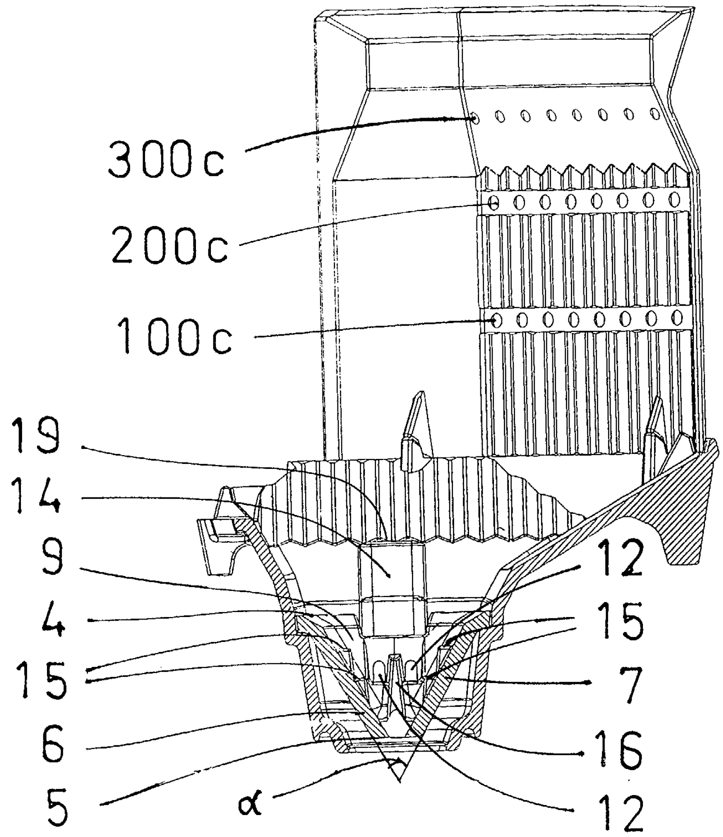
300c
200c
100c
19
14
9
4
15
6
5
α
12
15
7
16
12

FIG. 4

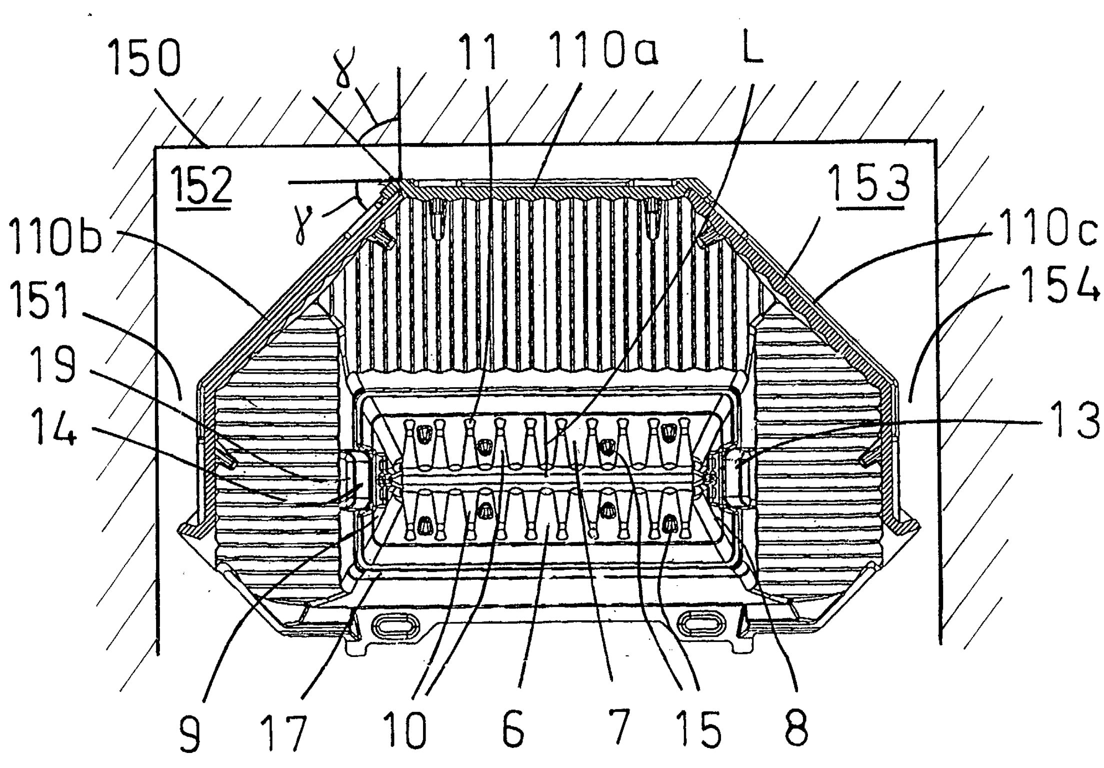
150
γ
11
110a
L
152
153
γ
110b
110c
151
154
19
14
13
9
17
10
6
7
15
8

FIG. 5

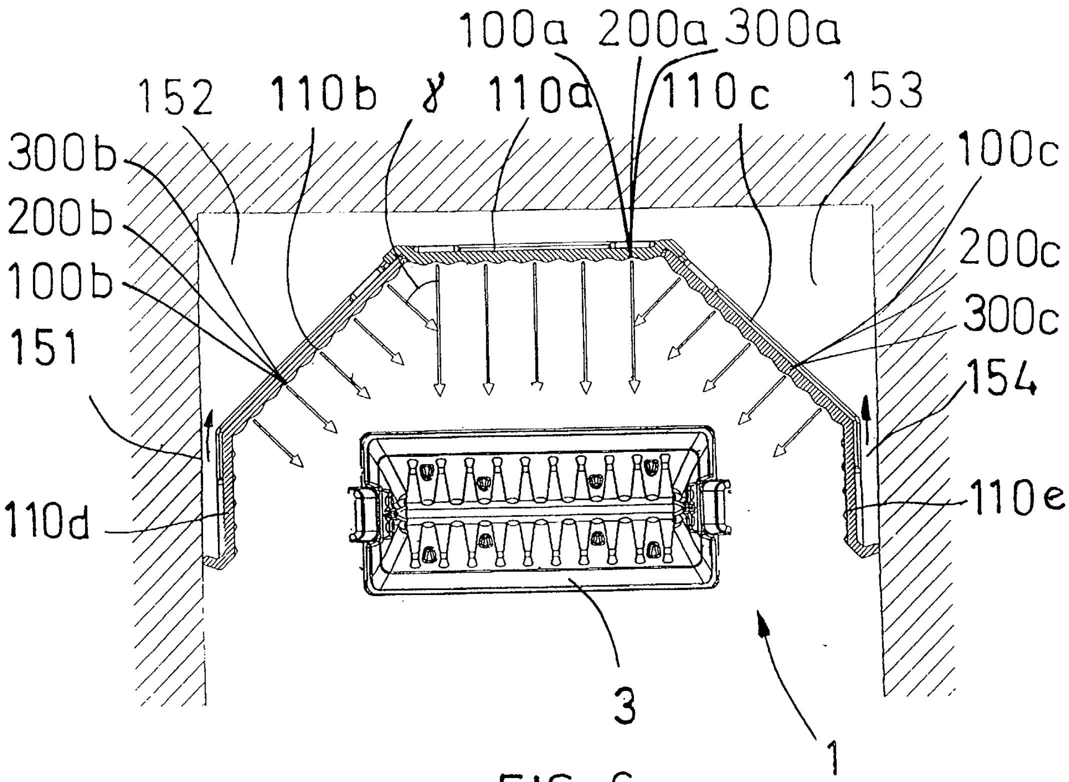
100a
200a
300a
152
110b
γ
110a
110c
153
300b
100c
200b
200c
100b
300c
151
154
110d
110e
3
1

FIG. 6

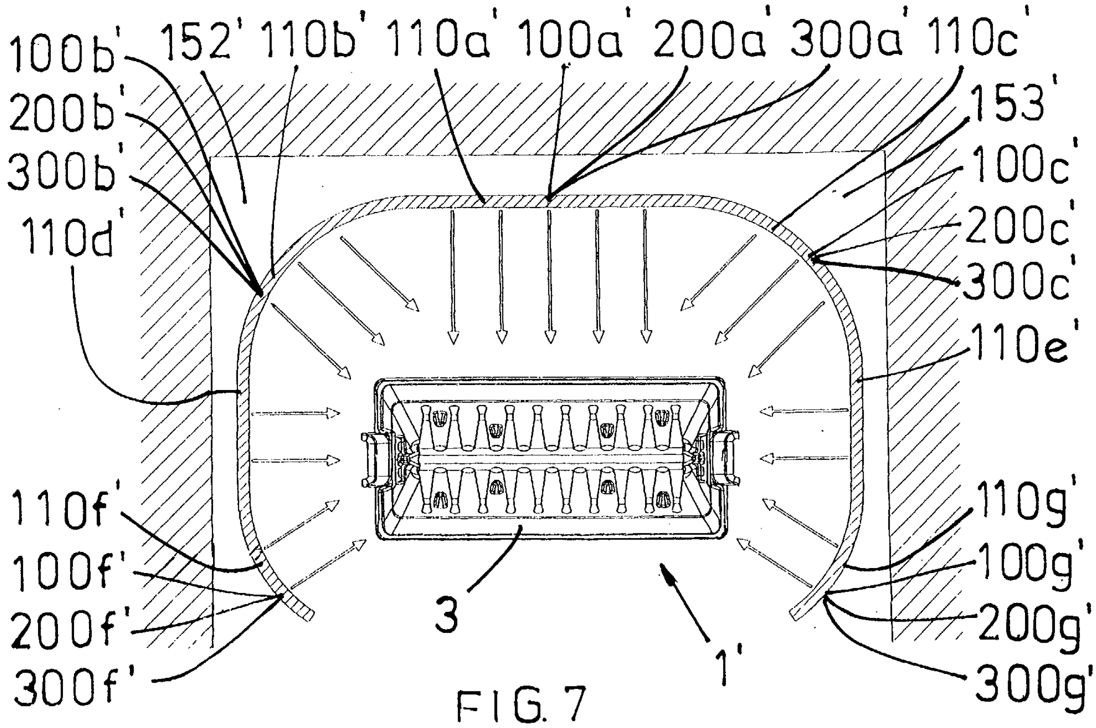
100b'
152'
110b'
110a'
100a'
200a'
300a'
110c'
200b'
153'
300b'
100c'
110d'
200c'
300c'
110e'
110f'
110g'
100f'
100g'
200f'
200g'
300f'
300g'
3
1'

FIG. 7

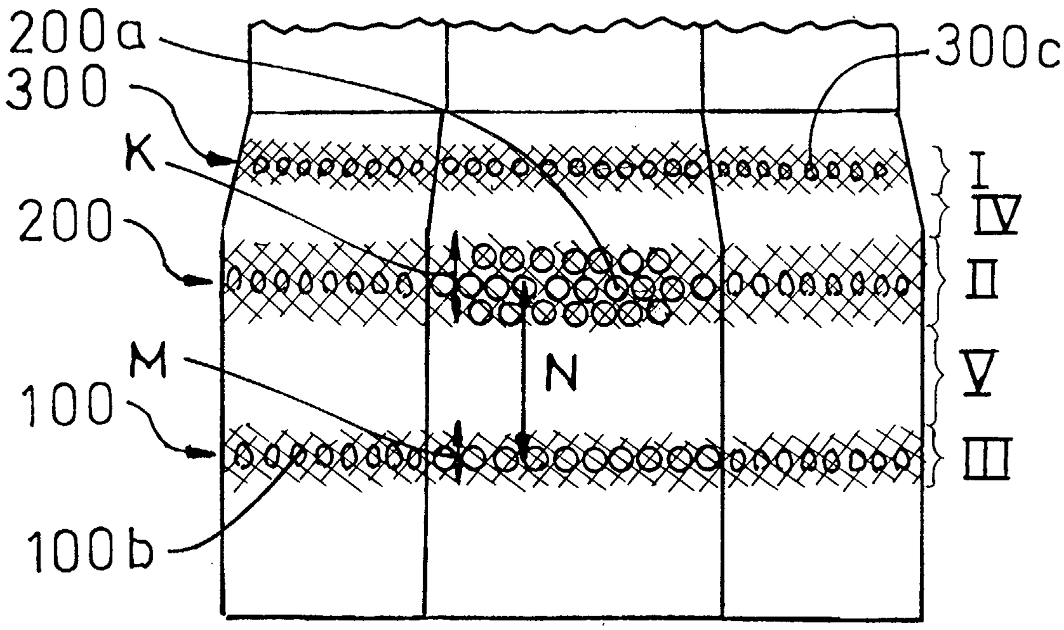


FIG. 8

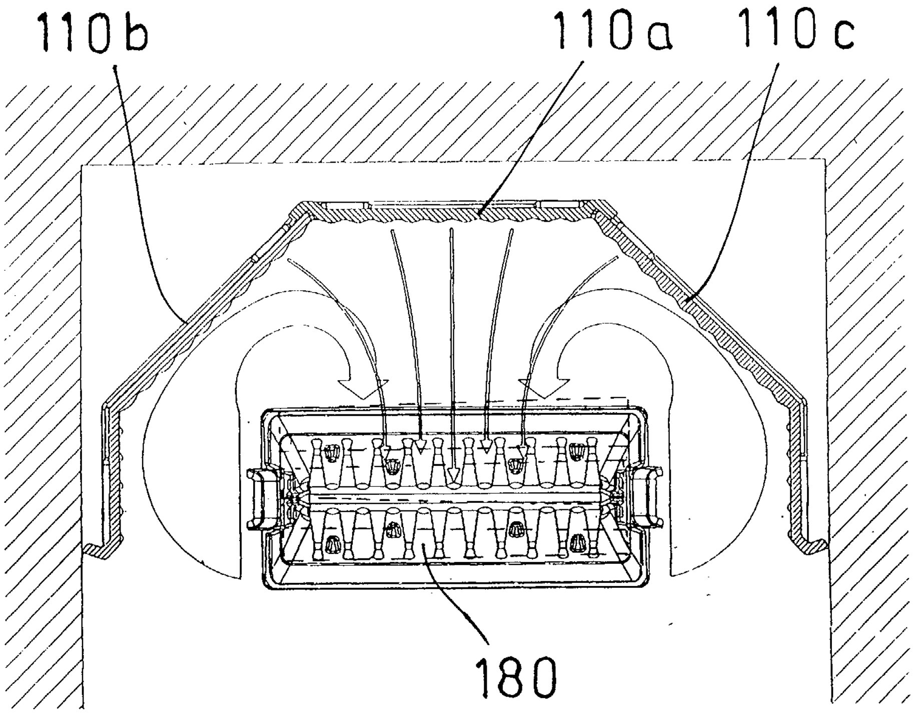


FIG. 9

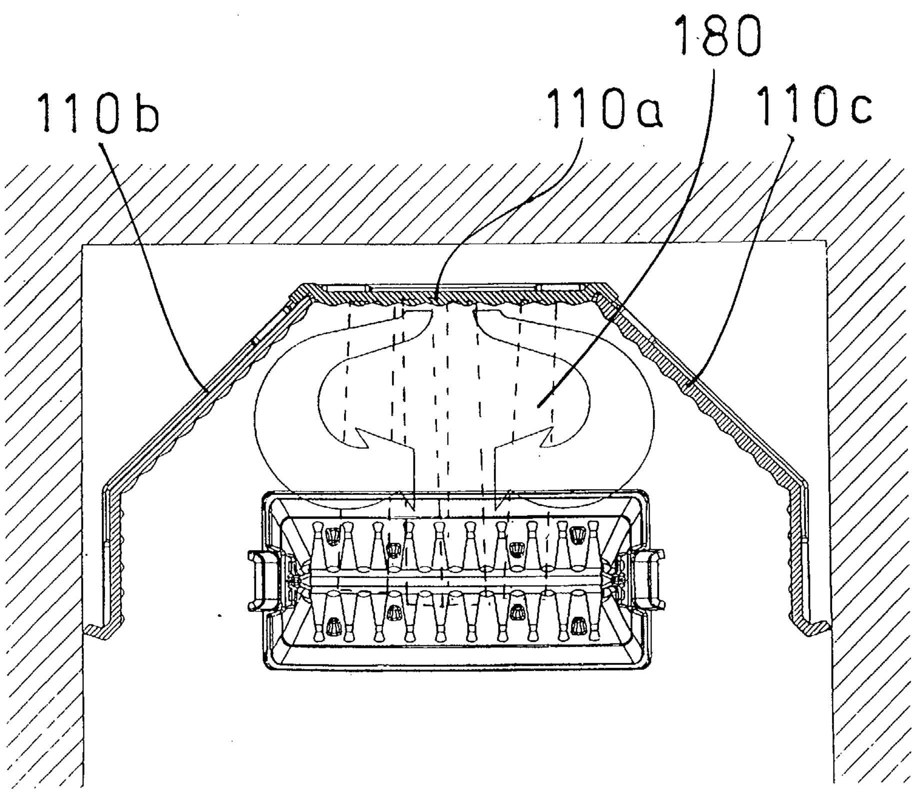


FIG. 10

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 03 39 6007

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F23B
F23L

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
| --- | --- | --- |
| MUNICH | 29 April 2003 | Theis, G |

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The members are as contained in the European Patent Office EDP file on
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29-04-2003

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