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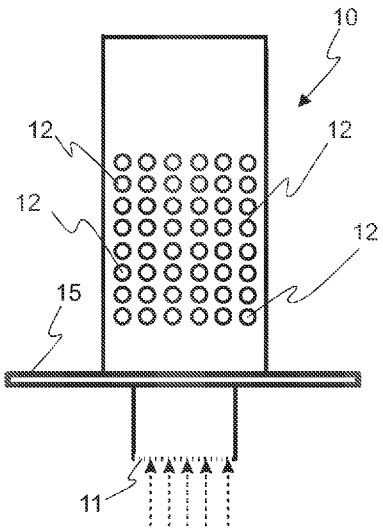

Fig. 1b

(57) Abstract: The invention relates to a secondary air casing (10) for conducting secondary air to different heights inside a firebox of a fireplace. The casing (10) comprises a hollow body, an air inlet (11) through which air is arranged to be flown inside the secondary air casing (10) to be preheated, and a plurality of air outlet openings (12) arranged in different heights of the secondary air casing (10) arranged to conduct preheated air to the firebox through at least the air outlet openings (12) that are on the height of the top of a burning wood charge inside the firebox. The invention further relates to a fireplace comprising a secondary air casing (10) and a grate (10), a method for supplying a secondary air to different heights of a firebox through air outlet openings (12) arranged at different heights on a secondary air casing (10), and to a secondary air casing retrofitting kit for a fireplace.

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A secondary air casing for a fireplace

Technical field

The present invention relates to a secondary air casing for a fireplace, a fireplace comprising a secondary air casing and a secondary air casing retrofitting kit for a fireplace.

Background

Serious efforts have been made for limiting wood-burning emissions of fire places in order to improve the air quality. When a regular grate is used in a fireplace and wood charge, for example, logs to be burned are placed on the grate, only combustion air is the primary air passing through the grate arranged underneath the wood charge. The gases released from these wood charge will burn among the wood charge, which further increases the heat of the wood charge, which in turn increases gasification. Therefore, the primary air is not adequate for burning all the released gases and thus a large amount of hydrocarbons and soot are not burned in the fireplace. This kind of burning with insufficient supply of oxygen may produce greater than desired amounts of wood-burning emissions. The wood-burning emission problem is even bigger when wood charge is added onto the surface of hot embers during wood-burning process.

To reduce wood-burning emissions, a structure underneath a grate has been developed. This structure comprises a hollow space for heating air, from where preheated air is conducted through the openings of the edge areas of the grate as a secondary air in addition to the primary air conducted through openings of the grate.

Summary

Now there has been invented a secondary air casing for a fireplace for conducting air to several heights of a firebox of a fireplace. Conducting of secondary air to several heights inside the firebox enables sufficient supply of oxygen during the entire wood-burning phase on top of a wood charge, from

the beginning of the wood-burning phase, when the fire is lighted and when the wood charge is high to the end phase of the wood-burning phase when the wood charge is burned down to the embers. The invention further relates to a fireplace comprising a secondary air casing and a secondary air casing retrofitting kit for a fireplace.

The invention relates to a secondary air casing for conducting secondary air to different heights inside a firebox of a fireplace. The secondary air casing comprises a hollow body, an air inlet through which air is arranged to be flown inside the secondary air casing to be preheated, and a plurality of air outlet openings arranged in different heights of the secondary air casing arranged to conduct preheated air to the firebox through at least the air outlet openings that are on the height of the top of a burning wood charge inside the firebox.

According to an embodiment, the air outlet openings are arranged in the middle part of the secondary air casing on the front of the secondary air casing. According to an embodiment, the air inlet is arranged at a bottom part of the secondary air casing. According to an embodiment, the secondary air casing comprises a connecting place for a grate under the air outlet openings. According to an embodiment, the secondary air casing further comprises an air pipe structure that is connected to at least two air outlet openings of the secondary air casing, which air pipe structure comprises a plurality of air outlet openings. According to an embodiment, the air pipe structure comprises a plurality of air outlet openings in the lower surface or at least one side of the air pipe structure. According to an embodiment, the air pipe structure comprises at least one rod that is pivotally connected on top of the secondary air casing. According to an embodiment, the secondary air casing further comprises a plurality of air outlet openings in the sides of the secondary air casing.

The invention further relates to a fireplace comprising a secondary air casing and a grate. The secondary air casing is arranged against a wall of a firebox and the grate is attached in front of the secondary air casing under the air outlet openings and primary air is arranged to be flown to the firebox through the grate openings. The secondary air casing comprises a hollow body, an air inlet through which air is arranged to be flown inside the secondary air casing to be preheated, and a plurality of air outlet openings arranged in different heights

of the secondary air casing arranged to conduct preheated air to the firebox through at least the air outlet openings that are on the height of the top of a burning wood charge inside the firebox.

According to an embodiment, the air outlet openings are arranged in the middle part of the secondary air casing on the front of the secondary air casing. According to an embodiment, the air inlet is arranged at a bottom part of the secondary air casing. According to an embodiment, the secondary air casing comprises a connecting place for a grate under the air outlet openings. According to an embodiment, the secondary air casing further comprises an air pipe structure that is connected to the secondary air casing so that preheated air can flow into the air pipe structure, which air pipe structure comprises a plurality of air outlet openings. According to an embodiment, the air pipe structure comprises a plurality of air outlet openings in the lower surface or at least one side of the air pipe structure. According to an embodiment, the air pipe structure comprises at least one rod that is pivotally connected on top of the secondary air casing. According to an embodiment, the secondary air casing further comprises a plurality of air outlet openings in the sides of the secondary air casing.

The invention further relates to a method for supplying a secondary air to different heights of a firebox through air outlet openings arranged at different heights on a secondary air casing. The method comprises supplying combustion air to the fireplace, supplying a primary air part of the combustion air through the grate under the wood charge, supplying a secondary air part of the combustion air into the hollow body of the secondary air casing, preheating the secondary air part in the secondary air casing, and supplying the preheated secondary air to the firebox through at least the air outlet openings that are just above the burning wood charge.

According to an embodiment, the method further comprises changing air outlet openings supplying the preheated secondary air to the air outlet openings that are arranged in the lower height at the secondary air casing for supplying the preheated secondary air just above the wood charge, when the level of wood charge lowers.

The invention further relates to a secondary air casing retrofitting kit for a fireplace. The secondary air casing retrofitting kit comprises a secondary air casing conducting secondary air to different heights inside a firebox of a fireplace and a grate arranged to be attached in front of the secondary air casing under the air outlet openings of the secondary air casing. The secondary air casing comprises a hollow body, an air inlet through which air is arranged to be flown inside the secondary air casing to be preheated, and a plurality of air outlet openings arranged in different heights of the secondary air casing arranged to conduct preheated air to the firebox through at least the air outlet openings that are on the height of the top of a burning wood charge inside the firebox.

According to an embodiment, the air outlet openings are arranged in the middle part of the secondary air casing on the front of the secondary air casing. According to an embodiment, the air inlet is arranged at a bottom part of the secondary air casing. According to an embodiment, the secondary air casing comprises a connecting place for a grate under the air outlet openings. According to an embodiment, the secondary air casing further comprises an air pipe structure that is connected to the secondary air casing so that preheated air can flow into the air pipe structure, which air pipe structure comprises a plurality of air outlet openings. According to an embodiment, the air pipe structure comprises a plurality of air outlet openings in the lower surface or at least one side of the air pipe structure. According to an embodiment, the air pipe structure comprises at least one rod that is pivotally connected on top of the secondary air casing. According to an embodiment, the secondary air casing further comprises a plurality of air outlet openings in the sides of the secondary air casing.

Brief description of the drawings

In the following, various embodiments of the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1a shows a secondary air casing according to an embodiment of the invention with a grate from a side;

Fig. 1b shows from the front a secondary air casing of figure 1a with a grate;

Figs. 2a-b show a secondary air casing according to an embodiment of the invention with a pile of wood logs on a grate;

Figs. 3a-d show a burning process of a pile of wood logs with a secondary air casing according to an embodiment;

Fig.4a shows a fireplace comprising a secondary air casing according to an embodiment from the front;

Fig.4b shows a horizontal cross-section through a fireplace comprising a secondary air casing according to an embodiment, taken along the line A-A in fig. 4a;

Fig.5a-b show a secondary air casing according to an embodiment;

Fig.6a-b show a secondary air casing according to an embodiment;

Fig.6c-f show a horizontal cross-section through a secondary air casing according to an embodiment from below, taken along the line B-B in fig. 6a and 6b;

Fig.7a shows a secondary air casing according to an embodiment;

Fig.7b shows a horizontal cross-section through a secondary air casing according to an embodiment from below, taken along the line C-C in fig. 7a;

Fig. 8 shows a flowchart of a method for supplying secondary air to different heights of a firebox through air outlet openings arranged at different heights on a secondary air casing according to an embodiment of the invention; and

Fig.9a-d show a secondary air casing according to an embodiment.

Detailed description

A fireplace may refer to regular fireplaces, heat-storing fireplaces, stoves, fireplace inserts, and heaters used for heating houses or other buildings or spaces. A heat storing fireplace, however, is a needed or at least preferable feature of a fireplace in cold conditions where regular heating is needed. However, wood-burning in fireplaces causes wood-burning emissions, sometimes even significant amounts of wood-burning emissions and particles when only insufficient amount of air i.e. oxygen is available. From a climate point of view, wood-burning emissions and particles are, of course, an undesirable side effect of wood burning processes of fireplaces. For example, when a regular grate is used in a fireplace and wood charge, for example wood logs, to be burned are placed on that grate, may a primary air passing through the grate arranged underneath the wood charge be the only combustion air in the wood-burning process. The gases released from these wood charge will burn among the wood charge, which further increases the heat of the wood charge, which in turn increases gasification. Therefore, the primary air is usually not adequate for burning all the gases released from the burning wood charge. The wood-burning emission problem even increases when additional wood charge is added onto the surface of hot embers during wood-burning process.

However, providing a sufficient amount of air for the burning wood charge just above the wood charge i.e. on top of the wood charge, where the flames are and burning takes place, i.e. to the so-called upper state of fire, the number of particles can be reduced even up to 90%. This kind of air conducting can be performed by a secondary air casing according to embodiments of the present invention. The secondary air casing comprises air outlet openings at different heights and it is thus capable to conduct air to the level of the upper state of fire, which level depends on the phase of wood-burning process and/or amount of wood charge in the firebox. Thus, the secondary air casing according to embodiments of the present invention will make the wood-burning process such that less emissions and particles are produced, because wood charge burns more efficiently and cleaner, when air is also conducted at least to the level of the upper state of fire, to flames. Diameter of the air outlet openings may

be, for example 6-20mm, for example 10mm. Air outlet openings may also have collars in some embodiments. Furthermore, in some embodiments, an air outlet opening of a secondary air casing may have different diameters comparing to other outlet openings or air outlet openings at different heights in the secondary air casing. The total area of the air outlet openings may be at least equal to the area of the air inlet, which lies at the bottom end of the secondary air casing and through which the air flows inside the casing. This enables efficient air circulation.

A secondary air casing according to embodiments of the present invention conducts air to several heights of a firebox of a fireplace through a plurality of air outlet openings arranged at different heights. Capability to provide secondary air to several heights inside the firebox i.e. firebox enables sufficient supply of air and oxygen to the upper state of fire i.e. on top of a wood log pile during the entire wood-burning phase i.e. process. The secondary air casing may provide air on top of a wood charge, from the beginning of the wood-burning phase, when the fire is lighted and when the pile is high to the end phase of the wood-burning phase when the wood charge is almost burned down to the embers. The secondary air casing may also provide air to the entire height of the burning wood charge, if wood logs are not positioned against the secondary air guide casing. The secondary air casing according to embodiments of the present invention may also be a kit for retrofitting a fireplace, when an existing grate is replaced by the secondary air casing according to embodiments of the present invention and a smaller grate arranged in front of the casing, under air outlet openings arranged at different heights.

As already mentioned above, when a sufficient amount of air for the burning wood charge just above the wood charge, where the flames are and burning takes place, i.e. to the so-called upper state of fire is provided, the number of particles can be reduced even up to 90%. Even if the secondary air casing has several openings that are not covered by a wood charge, the upper state of fire is the main area whereto the secondary air is conducted. In the upper state of fire, there is a vortex that entrains the secondary air to flow to the upper state of fire through those air outlet openings that are at the level of the upper state of fire. Thus, the structure of the secondary air casing having a plurality of air outlet openings

arranged at different heights is suitable for providing air for the upper state of fire at all wood-burning phases, from the beginning to end, thus making the burning process more effective and cleaner.

The future emission limits or just one's desire to produce less emissions, may cause a need for a structure that produces a sufficient amount of air to upper state of fire of the burning wood log pile, but existing fireplace may not such that this kind of production of air is possible. Therefore, there is also a need for a retrofittable secondary air casing suitable to be retrofitted to an existing fireplace. When retrofitting an existing fireplace, a regular grate of the existing fireplace is replaced by a secondary air casing according to an embodiment of the invention and a smaller grate suitable to be used with the secondary air casing so that area of the regular grate in the bottom area of the firebox is replaced by the secondary air casing and the smaller grace. However, it should be noted that a secondary air casing according to an embodiment of the invention may also be an integrated part of a fireplace.

In the following, embodiments of the invention will be described in the context of figures 1 to 9. It is to be noted, however, that the invention is not limited to shown embodiments. In fact, the different embodiments have applications in any environment where a secondary air casing is applicable. Most secondary air casings of figures are shown as cross-sectional view in order to clarify the positions of air inlet and outlet openings in secondary air casings.

Figure 1a shows from a side a secondary air casing 10 according to an embodiment of the invention. In figure 1a there is also shown a grate 15 that is attached to the casing 10 or positioned next to the casing 10. The casing 10 has a hollow body. The casing 10 comprises an air inlet 11 in a first end that is the bottom end of the casing 10 for receiving air inside the hollow body, and a plurality of air outlet openings 12 for conducting air out from the body of the casing 10 for the wood charge arranged on the grate 15. The plurality of air outlet openings 12 are arranged, in this embodiment, in the middle part of the casing 10, but it is also possible that they are arranged to the second end that is the upper end of the casing 10. An example, of this kind of structure is shown in figure 2b. The number of air outlet openings 12 and their height levels may be freely selected, for example, based on the fireplace. There may be a

connecting place for the grate 15 under the openings 12. The connecting place may be, for example, a flat surface on which a side of the grate 15 could lie or could be fixed.

The secondary air casing 10 is arranged to be positioned inside a fireplace such that it is positioned against a wall, for example, a back wall of a firebox of a fireplace so that the air inlet 11 is downward. Inside the hollow body the air is going to be preheated when wood charge is burned on the grate 15. Through the plurality of air outlet openings 12 the preheated air is arranged to be flow from the hollow body of the casing 10 to the firebox and above the burning wood charge arranged on the grate 15. The idea of air outlet openings 12 arranged at different heights from the bottom of the firebox is that preheated secondary air can always, despite the burning phase and/or height of wood charge, be conducted to the height of the top of the wood charge, to the flames. It is possible that preheated secondary air is also conducted to other heights, but at least at the height of the top of the wood charge. The secondary air casing 10 may be made of, for example, stainless steel or black iron. The thickness of the material may be, for example 1-10mm.

Figure 1b shows from the front a secondary air casing of figure 1a with the grate 15. As can be seen, there are 48 circular air outlet openings 12 in this embodiment, but as already said above, the number of openings 12 can be different, but in addition, the shape and placement of openings 12 can be different. In this embodiment, the lower part of the casing 10 is narrower than the part of the casing 10 above the grate 15, but it is also possible that it is as wide as the rest of the casing 10.

It is also possible that the casing comprises more than one air inlet or at least one air inlet in some other part of the casing than in the bottom end of the casing. The casing may, for example, comprise at least one air inlet in the back part of the casing or in one or two sides of the casing, for example in the lower part of the casing. Furthermore, it is possible that air is brought to the casing from outside instead of from the space wherein the fireplace is.

Figure 2a shows a secondary air casing 20 according to an embodiment of the invention. A pile of wood logs 21, as a wood charge, is arranged on a grate 23. In this embodiment, logs 21 are not leaning against the casing 20 i.e. the logs

21 are not placed against the casing 20 and air outlet openings 22 of the casing 20. Therefore, the preheated air could be conducted through openings 22 of every height to the logs 21, but the amount of conducted air is highest in the upper state of fire. This height is indicated by an arrow 24.

Figure 2b shows a secondary air casing 25 according to an embodiment of the invention and a pile of wood logs 21 is again arranged on a grate 23. In this embodiment, the casing 25 has air outlet openings 22 in the upper part of the casing 25. Furthermore, this casing 25 is not formed curved as casings in other examples, but the vertical cross section of the casing 25 is straight. The height of openings 22 through which the main amount of secondary air is supplied to the firebox, the upper state of fire, is indicated by an arrow 24.

It should also be noted that the casing can also have other forms i.e. the vertical cross section can have a form of letter S, half circle etc. In addition to shape, also height and width of a secondary air casing can be selected freely, for example, based on a size of a firebox of a fireplace.

Figures 3a-3d show a burning process of a wood charge with a secondary air casing 30 according to an embodiment of the invention. There is a pile of burning logs 31, as a wood charge, arranged on the grate 32. There are flames 33 above the logs 31.

In the figure 3a the burning process has just started and the pile of logs 31 is high. The preheated air could be conducted through air outlet openings 34 of heights that are not blocked by logs 31. But again, the amount of secondary air flown from the casing 30 is highest in the upper state of fire. This air flow is indicated by an arrow 35.

In the figure 3b the burning process is proceeded and the pile of logs 31 is lowered. The burning process is in a middle phase. But again, the highest amount of conducted air is again conducted to the upper state of fire. This air flow is again indicated by the arrow 35.

In the figure 3c the burning process is further proceeded and the pile of logs 31 is further lowered. The burning process is still in the middle phase. But

again, the highest amount of conducted air is again conducted to the upper state of fire. This air flow is again indicated by the arrow 35.

In the figure 3d the burning process is further proceeded and the pile of logs 31 is almost burned. The burning process is in the end phase. But again, the highest amount of conducted air is again conducted to the upper state of fire. Tätä air flow is again indicated by the arrow 35.

Figure 4a shows, from the front side, a fireplace 40 comprising a secondary air casing 41 according to an embodiment. The secondary air casing 41 is arranged against the back wall of the firebox 43 of the fireplace 40. The combustion air may flow to the secondary air casing 41 from the surrounding room or straight from outside the house, for example, through an ash door 42. Inside the secondary air casing 41 a part of the combustion air that is the secondary air preheats before it flows through air outlet openings 44 of the casing 41 to the flames and the upper state of fire. The other part of the combustion air i.e. the primary air is arranged to flow through the grate openings (45 shown in figure 4b) to the firebox 43.

Figure 4b shows a horizontal cross-section through the fireplace 40 comprising the secondary air casing 41 according to an embodiment, taken along the line A-A in figure 4a. In figure 4b, the grate 45 and its openings 46 are shown. The grate 45 is positioned in front of the secondary air casing 41 to the front part of the firebox 43. In this embodiment, openings 46 are circular, but they may also be, for example oval or rectangular. Size of openings 46may also be different.

Figure 5a shows from a side a secondary air casing 50 according to an embodiment of the invention. In figure 5a there is also shown a grate 55 that is attached to the casing 50. The casing 50 has a hollow body. The casing 50 comprises an air inlet 51 in the bottom end of the casing 50 for receiving air inside the hollow body, and a plurality of air outlet openings 52 in the middle part of the body for conducting air out from the body of the casing 50 for the wood charge arranged on the grate 55. The casing 50 further comprises an upper air outlet opening a53 in the upper part of the casing 50 for conducting preheated air out from the body of the casing 50 to the upper part of the firebox into which this casing 50 is installed.

Figure 5b shows from the front a secondary air casing 56 according to an embodiment of the invention. In figure 5b there is also shown a grate 58 that is attached to the casing 56. The casing 56 has a hollow body. The casing 56 comprises an air inlet 59 in the bottom end of the casing 56, and a plurality of air outlet openings 57 in the middle part of the hollow body. The casing 56 further comprises a plurality of side air outlet openings 54 in the sides of the casing 56 for conducting preheated air out from the body of the casing 56 to side areas of this casing 56.

Figure 6a shows from a side a secondary air casing 60 according to an embodiment of the invention. In figure 6a there is also shown a grate 65 that is attached to the casing 60. The casing 60 of this embodiment further comprises an air pipe structure 64 comprising a plurality of air outlet openings 66 in addition to a plurality of air outlet openings 61 arranged in the body of the casing 60. The air pipe structure 64 may be a hollow arc or it may have an angular shape. At least both ends of the air pipe structure 64 are connected to air outlet openings 61 arranged in the body of the casing 60 so that air flows from the casing 60 to the pipe structure 64. When the secondary air casing 60 is installed in a firebox the air pipe structure 64 protrudes toward the front part of the firebox. The wood charge is arranged to be positioned under the air pipe structure 64. The air outlet openings 66 of the air pipe structure 64 are arranged in the lower surface of the pipe structure 64 so that preheated will be conducted downwards to the fire and wood charge under the pipe structure 64. However, it is also possible that air outlet openings of the air pipe structure are arranged to the side(s) of the air pipe structure and/or to the upper surface of the air pipe structure instead or in addition to the lower surface of the pipe structure.

Figure 6b shows from the front the secondary air casing 60 comprising the air pipe structure 64 of figure 6a.

Figures 6c-f show a horizontal cross-section through the secondary air casing 60 with the air pipe structure 64 according to an embodiment, taken along the line B-B in figures 6a and 6b. In figures 6c-f, the air pipe structure 64 and its openings 66 are shown. The air pipe structure 64 is fixed in front of the secondary air casing 60. In the embodiment of 6c, the air pipe structure 64 has an angular shape and it is connected to two air outlet openings 61 of the casing

60. In the embodiment of 6d, the air pipe structure 64 has an arc shape and it is connected to two air outlet openings 61 of the casing 60. In the embodiment of 6e, the air pipe structure 64 has again an angular shape, but now it is connected to three air outlet openings 61 of the casing 60. The third connection is made by an additional air pipe connection that is added between an air outlet opening 61 of the casing 60 and the air pipe structure 64. In the embodiment of 6f, the air pipe structure 64 has an arc shape and it is connected to three air outlet openings 61 of the casing 60.

Figure 7a shows from the front a secondary air casing 70 according to an embodiment of the invention. In figure 7a there is also shown a grate 75 that is attached to the casing 70. The casing 70 of this embodiment further comprises an air pipe structure 74 comprising a plurality of air outlet openings 76 in addition to a plurality of air outlet openings 71 arranged in the body of the casing 70. The air pipe structure 74 of this embodiment comprises three separate hollow rods, which protrude forward towards the front part of the firebox when the casing 70 is installed in a fireplace. The air outlet openings 76 of the air pipe structure 64 are arranged in the lower surface of the rods so that preheated will be conducted downwards to the fire and wood charge under the pipe structure 74. However, it is also possible that air outlet openings of the air pipe structure are arranged to the side(s) of the rods and/or to the upper surface of the rods instead or in addition to the lower surface of the rods. It is also possible that the air pipe structure 74 comprises only 1 rod or 2 rods, but it may also comprise more than 3 rods, for example 4 to 6 rods.

Figure 7b shows a horizontal cross-section through the secondary air casing 70 with the air pipe structure 74 according to an embodiment, taken along the line C-C in figures 7a. In figure 7b, the air pipe structure 674 and its openings 76 are shown. The rods of the air pipe structure 74 are again fixed in front of the secondary air casing 70.

The shape, size, number or diameter of air outlet openings of the air pipe structure or height of placement of the air pipe structure can be selected as wanted, for example based on the firebox or fireplace. The air outlet openings of the air pipe structure may have smaller diameter than air outlet openings arranged in the body of the casing. The air pipe structure may make the wood

burning process even cleaner because it provides secondary air to the wider area above the wood charge.

Figure 8 shows a flowchart of a method 80 according to an embodiment of the invention, wherein the method comprises supplying secondary air to different heights of a firebox through air outlet openings arranged at different heights on a secondary air casing, wherein the height of supplied secondary air depends on a level of burning wood charge in a fireplace. In step 81 combustion air flows i.e. is supplied to the fireplace and the combustion air divides into a primary air and a secondary air. In step 82 the primary air is supplied through the grate openings under the wood charge, for example, wood logs. In step 83 the secondary air is supplied into the hollow body of the secondary air casing through an air inlet opening. Steps 82 and 83 may also happen similarly or in reverse order. In step 84 the secondary air is preheated in the secondary air casing. In step 85 the preheated secondary air is supplied to the firebox through at least those openings that are just above the wood charge. Further, in the further steps of the method 80, when the wood charge burns, the openings arranged in the lower height of the secondary air casing i.e. openings at the current level of wood charge are arranged to supply the preheated air above the wood charge. In other words, air outlet openings change to openings that are arranged at lower level when the level of wood charge lowers. All steps of the method 80 may also happen similarly, when the wood burning process is in progress.

Figure 9a shows from a side of a secondary air casing 90 according to an embodiment of the invention. In figure 9a there is also shown a grate 95 that is attached to the casing 90. The casing 90 of this embodiment comprises sloping sidewalls 97 i.e. the front side of the casing 90 comprising a plurality of air outlet openings 91 is narrower than the wider back side of the casing 90 arranged to be positioned against a wall of a firebox. The sloping sidewalls 97 comprises a plurality of air outlet openings 92 through which the preheated air can also flow to the firebox in addition to a plurality of air outlet openings 91 arranged in the center body of the casing 90.

Further to this, the casing 90 of this embodiment comprises an air pipe structure 93 comprising a plurality of air outlet openings 94 in at least one side through which preheated will be flow to the firebox and above wood charge

that is under the air pipe structure 93. The air pipe structure 93 of this embodiment comprises three hollow rods, which protrude forward towards the front part of the firebox when the casing 90 is installed in a fireplace. The rods of this air pipe structure 93 are pivotally attached i.e. connected to openings that are arranged to the upper surface of the casing 90 for rods. And through these openings of upper surface of the casing 90 preheated air is arranged to flow into rods from the casing 90 and further to the firebox through air outlet openings 94 of rods. The pivotal attachment enables turning rods on side(s), for example when wood logs are added to the firebox and when rods are hot. This kind of structure increases the safety of the air pipe structure 93. The rods turn in horizontal direction. It is possible to turn just one rod or two rods or all rods, as needed.

The air outlet openings 94 of the air pipe structure 93 may alternatively be arranged in the lower surface of the rods and/or to the upper surface of the rods instead or in addition to the side(s) of the rods. It is also possible that the air pipe structure 93 comprises only 1 rod or 2 rods, but it may also comprise more than 3 rods, for example 4 to 6 rods that are pivotally fastened above the casing 90. Further it is possible that the air pipe structure 93 is connected to a secondary air casing that does not comprise sloping sidewalls or to a secondary air casing that comprises air outlet openings in the sidewalls of the casing or that does not comprise any air outlet openings in the sidewalls of the casing.

Figure 9b shows the secondary air casing 90 of figure 9a from the front. Figures 9c and 9d show the secondary air casing 90 of figure 9a and 9b from above. In the figure 9c it is shown a situation, where rods are not turned. Whereas, in the figure 9d it is shown a situation, where all rods are turned. Two of them are turned to the first side and one to the second side.

The shape, size, number of air outlet openings, or diameter of air outlet openings of the casing, sloping sidewalls and air pipe structure can be selected as wanted, for example based on the firebox or fireplace. The air outlet openings of the casing, sloping sidewalls and air pipe structure air pipe structure may together make the wood burning process even cleaner because they provide secondary air to wider area of a firebox.

The air arranged to be used as combustion air flows to the fireplace from the surrounding room or straight from outside the house through an ash door. This ash door may have at least one partition wall that divides the incoming air into primary air and secondary air already in the ash box. The ratios of primary air and secondary air volumes entering to the firebox may vary at different stages of the burning process. For example, at the beginning of the burning process the amount of primary air may be, for example 50% or more, whereas in the most intense phase of the burning process, the amount of secondary air increases, it may be, for example over 50-70%.

It should also be noted that a grate may be arranged on the support beams, whereby primary air can flow not only through the grate openings but also below the grate edges to the firebox.

It is obvious that the present invention is not limited solely to the above-presented embodiments, but it can be modified within the scope of the appended claims. Also, embodiments of the secondary air casing can be combined. For example, one secondary air casing can comprise a plurality of openings, a plurality of side openings, an upper air outlet opening and/or an air pipe structure.

Claims:

1. A secondary air casing (10) for conducting secondary air to different heights inside a firebox of a fireplace, which secondary air casing (10) comprises
a hollow body,
an air inlet (11) through which air is arranged to be flown inside the secondary air casing (10) to be preheated, and
a plurality of air outlet openings (12) arranged in different heights of the secondary air casing (10) arranged to conduct preheated air to the firebox through at least the air outlet openings (12) that are on the height of the top of a burning wood charge inside the firebox,
characterized in that the lower part of the secondary air casing (10) is narrower than the part of the secondary air casing (10) above the grate (15).

2. A secondary air casing according to claim 1, wherein the air outlet openings (12) are arranged in the middle part of the secondary air casing (10) on the front of the secondary air casing (10).

3. A secondary air casing (10) according to claim 1, wherein the air inlet is arranged at a bottom part of the secondary air casing.

4. A secondary air casing (10) according to any of claims 1 to 3, wherein the secondary air casing comprises a connecting place for a grate (15) under the air outlet openings (12).

5. A secondary air casing (10) according to any of claims 1 to 4, wherein the secondary air casing (10) further comprises an air pipe structure (64, 74) that is connected to the secondary air casing (10), which air pipe structure (64, 74) comprises a plurality of air outlet openings (66, 76).

6. A secondary air casing (10) according to claim 5, wherein the air pipe structure (64, 74) comprises a plurality of air outlet openings (66, 76) in the lower surface or at least one side of the air pipe structure (64, 74).

7. A secondary air casing (10) according to claim 5 or 6, wherein the air pipe structure (74) comprises at least one rod that is pivotally connected on top of the secondary air casing (10).

8. A secondary air casing (10) according to any of claims 1 to 7, wherein the secondary air casing (10) further comprises a plurality of air outlet openings (54) in the sides of the secondary air casing (10).

9. A fireplace (40) comprising a secondary air casing (10) according to any of claims 1 to 8 and a grate (15), wherein the secondary air casing (10) is arranged against a wall of a firebox (43) and the grate (15) is attached in front of the secondary air casing (10) under the air outlet openings (12) and primary air is arranged to be flown to the firebox (43) through the grate openings.

10. A method for supplying a secondary air to different heights of a firebox through air outlet openings (12) arranged at different heights on a secondary air casing (10), wherein the method comprises

supplying combustion air to the fireplace,

supplying a primary air part of the combustion air through a grate (15) under the wood charge,

supplying a secondary air part of the combustion air into the hollow body of the secondary air casing (10) through the lower part of the secondary air casing (10) that is narrower than the part of the secondary air casing (10) above the grate (15),

preheating the secondary air part in the secondary air casing (10), and

supplying the preheated secondary air to the firebox through at least the air outlet openings (12) that are just above the burning wood charge.

11. A method for supplying a secondary air according to claim 10, wherein the method further comprises
changing air outlet openings (12) supplying the preheated secondary air to the air outlet openings (12) that are arranged in the lower height at the secondary air casing (10) for supplying the preheated secondary air just above the wood charge, when the level of wood charge lowers.

12. A secondary air casing retrofitting kit for a fireplace (40), wherein the secondary air casing retrofitting kit comprises a secondary air casing (10) according to any of claims 1 to 8 for conducting secondary air to different heights inside a firebox (43) of the fireplace (40) and a grate (15) arranged to be attached in front of the secondary air casing (10) under the air outlet openings (12) of the secondary air casing (10).

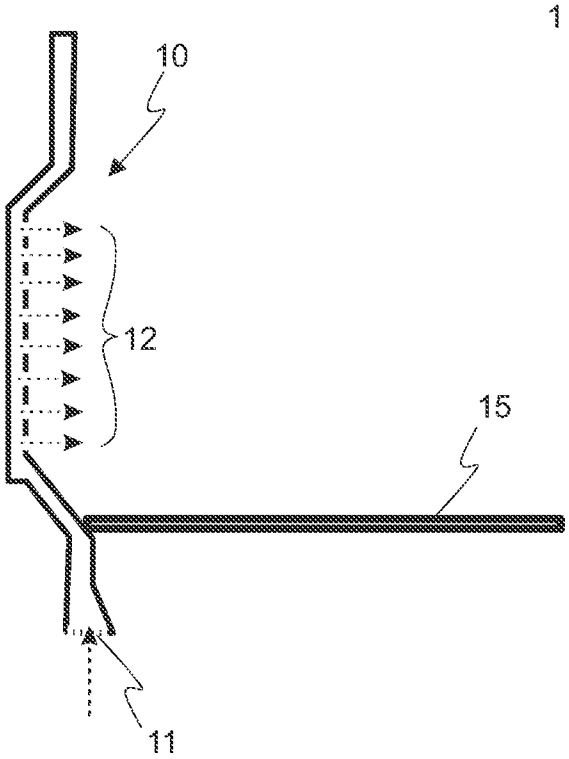

Fig. 1a

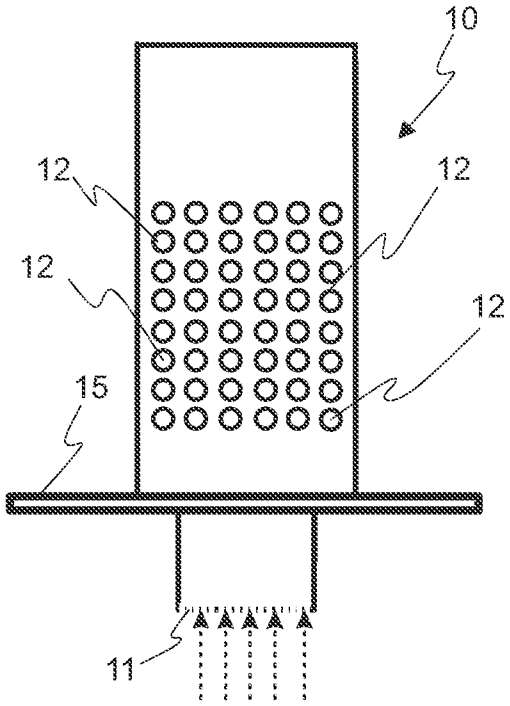

Fig. 1b

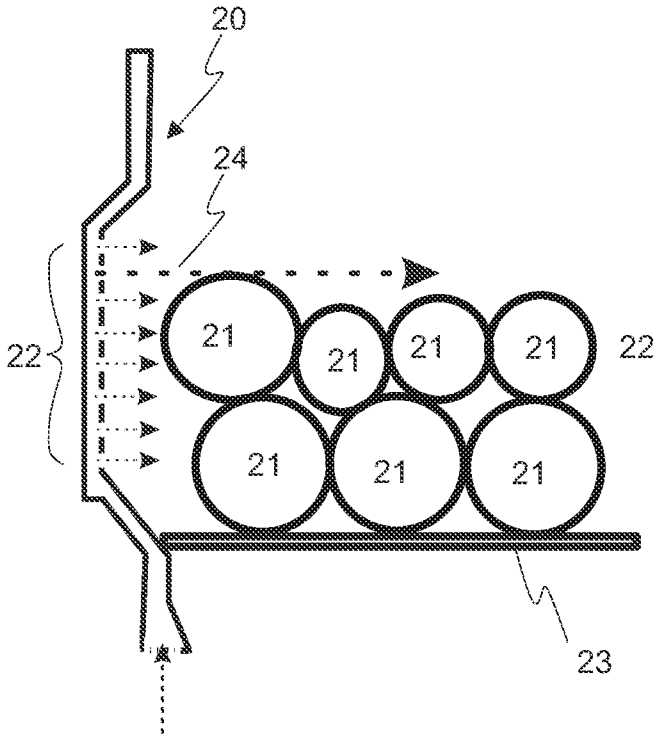

Fig. 2a

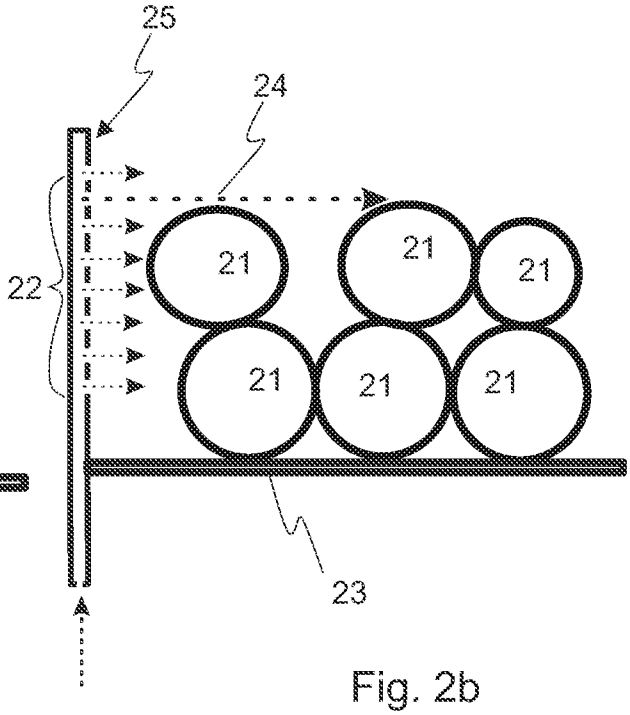

Fig. 2b

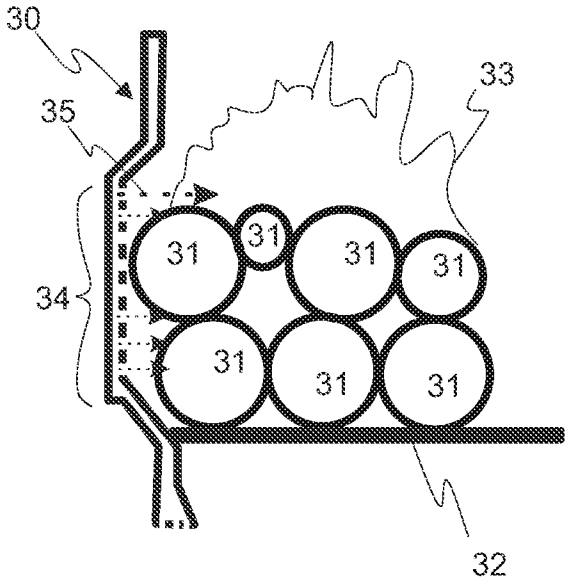

Fig. 3a

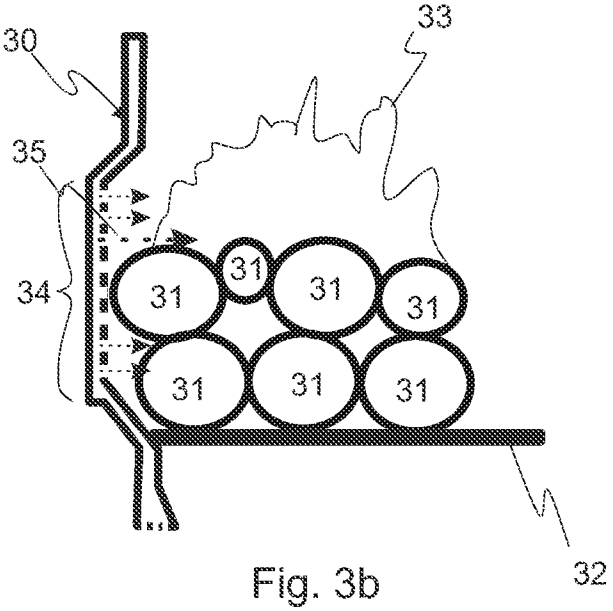

Fig. 3b

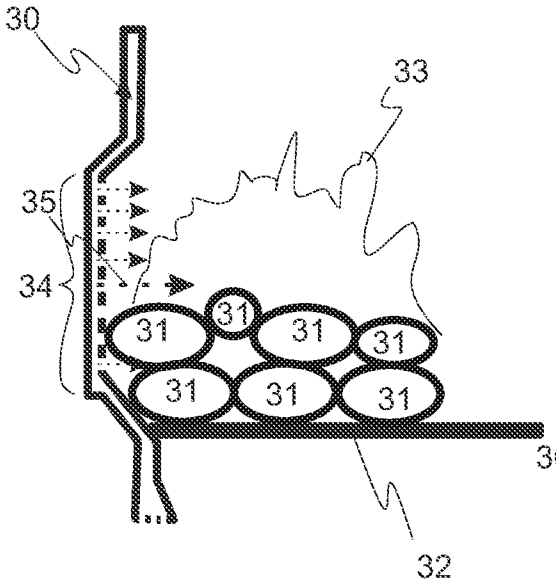

Fig. 3c

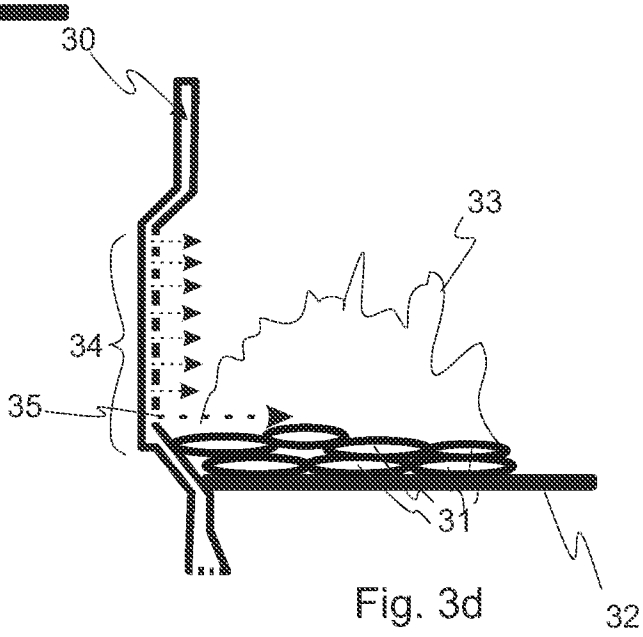

Fig. 3d

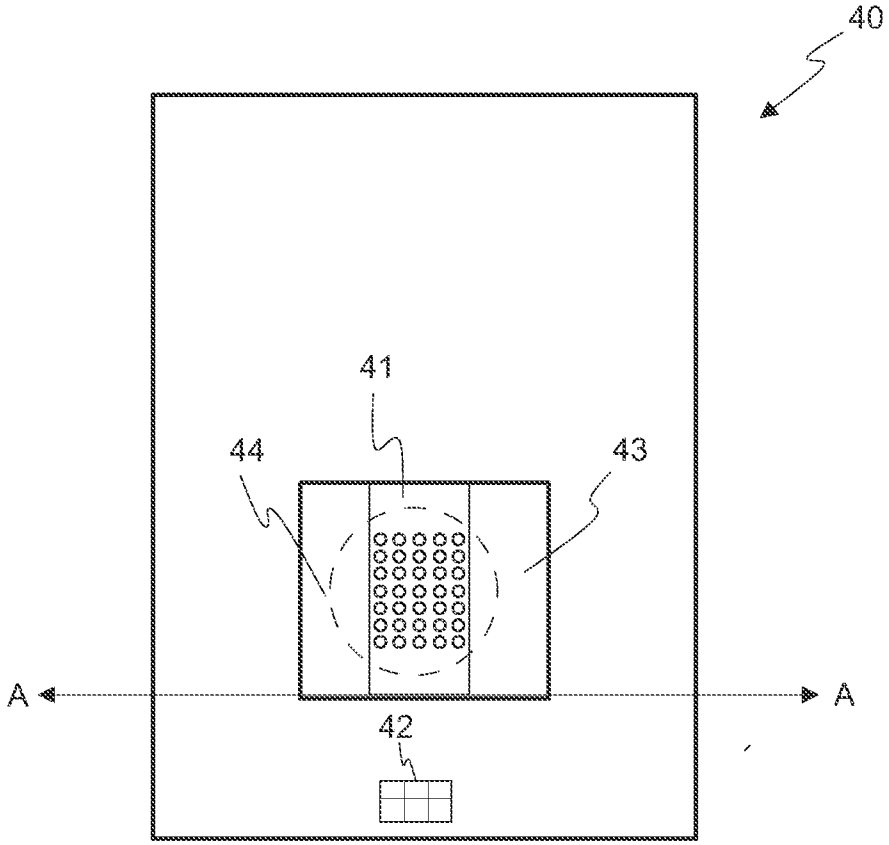

Fig. 4a

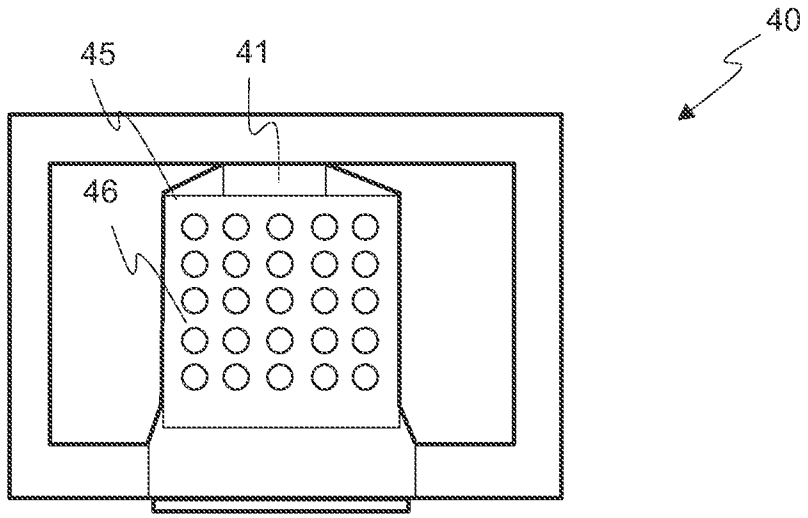

Fig. 4b

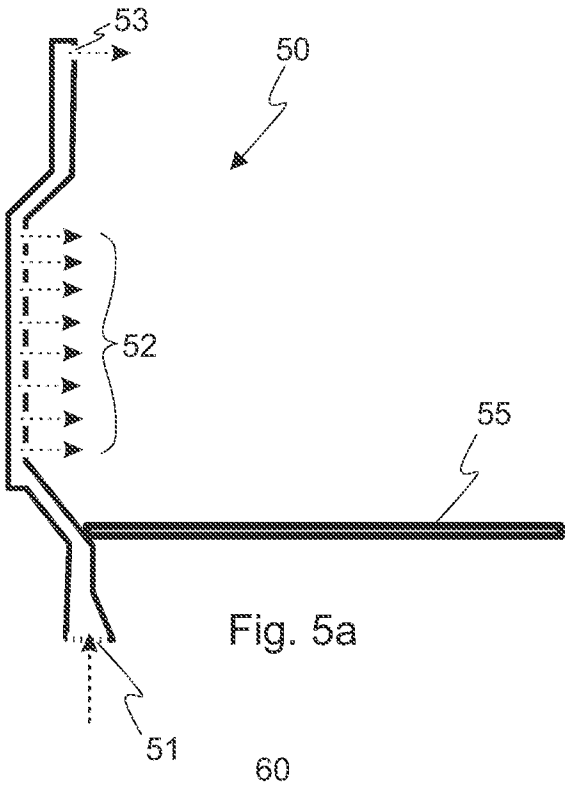

Fig. 5a

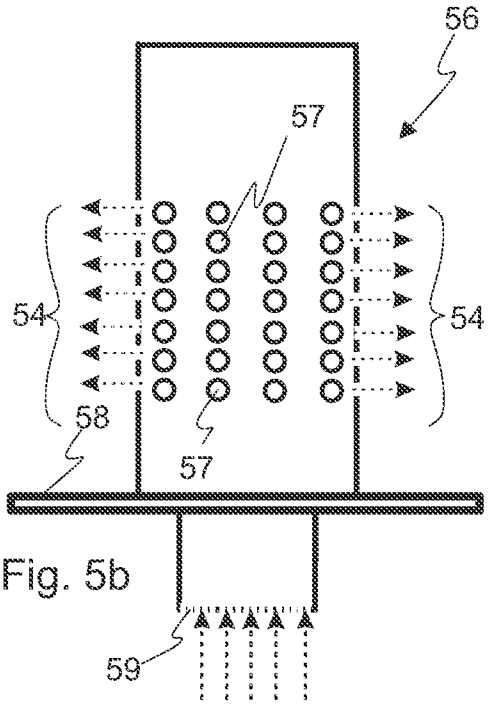

Fig. 5b

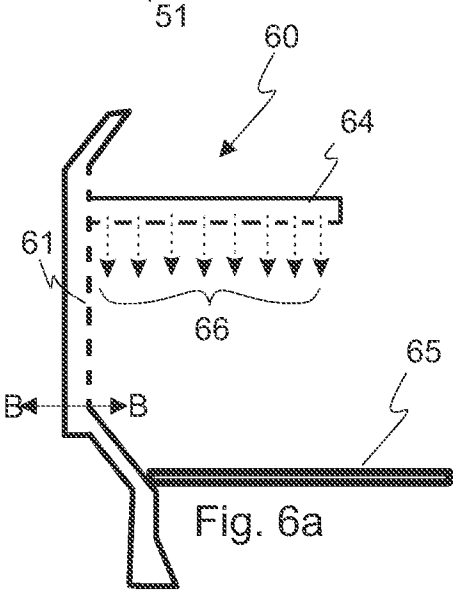

Fig. 6a

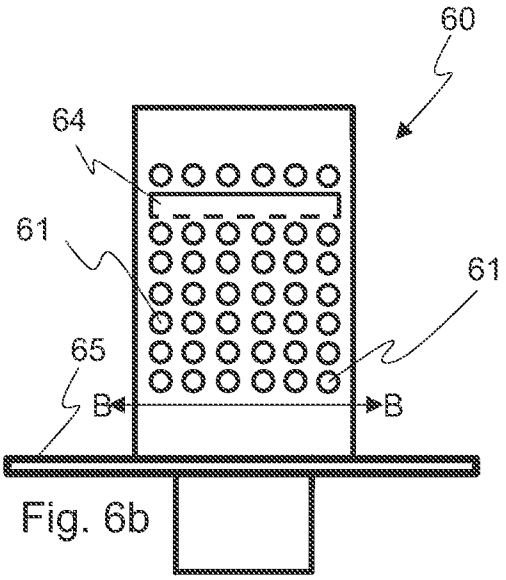

Fig. 6b

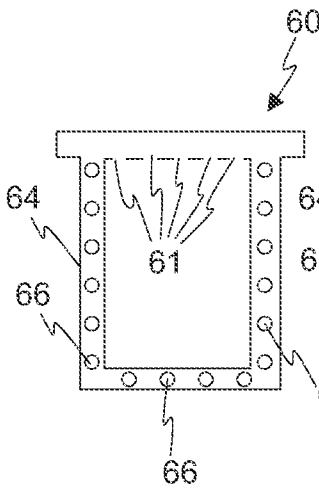

Fig. 6c

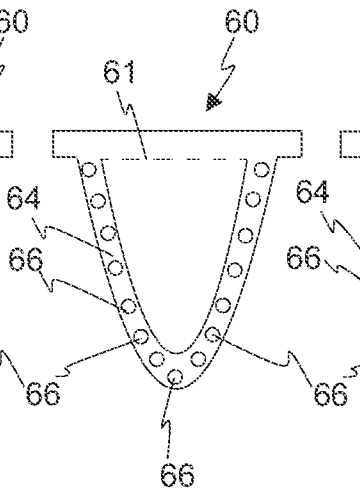

Fig. 6d

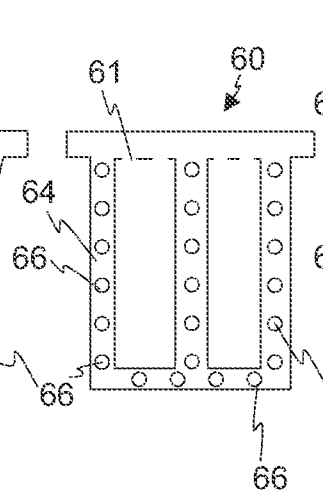

Fig. 6e

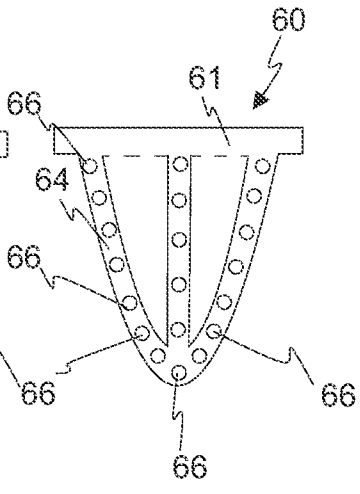

Fig. 6f

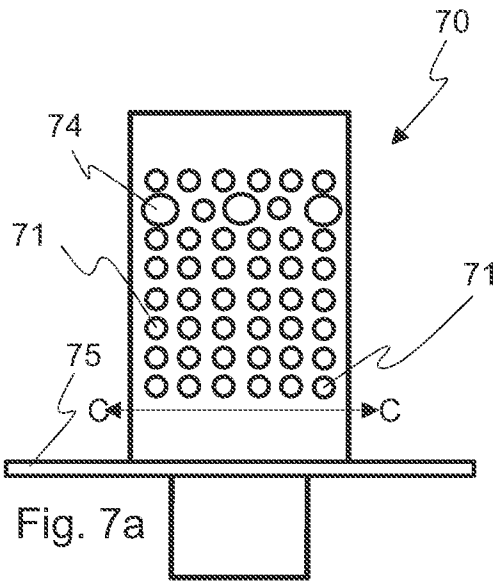

Fig. 7a

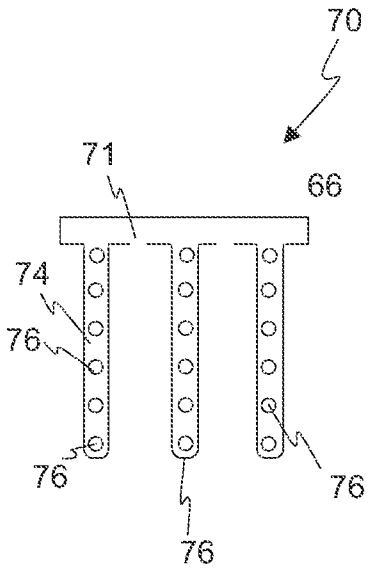

Fig. 7b

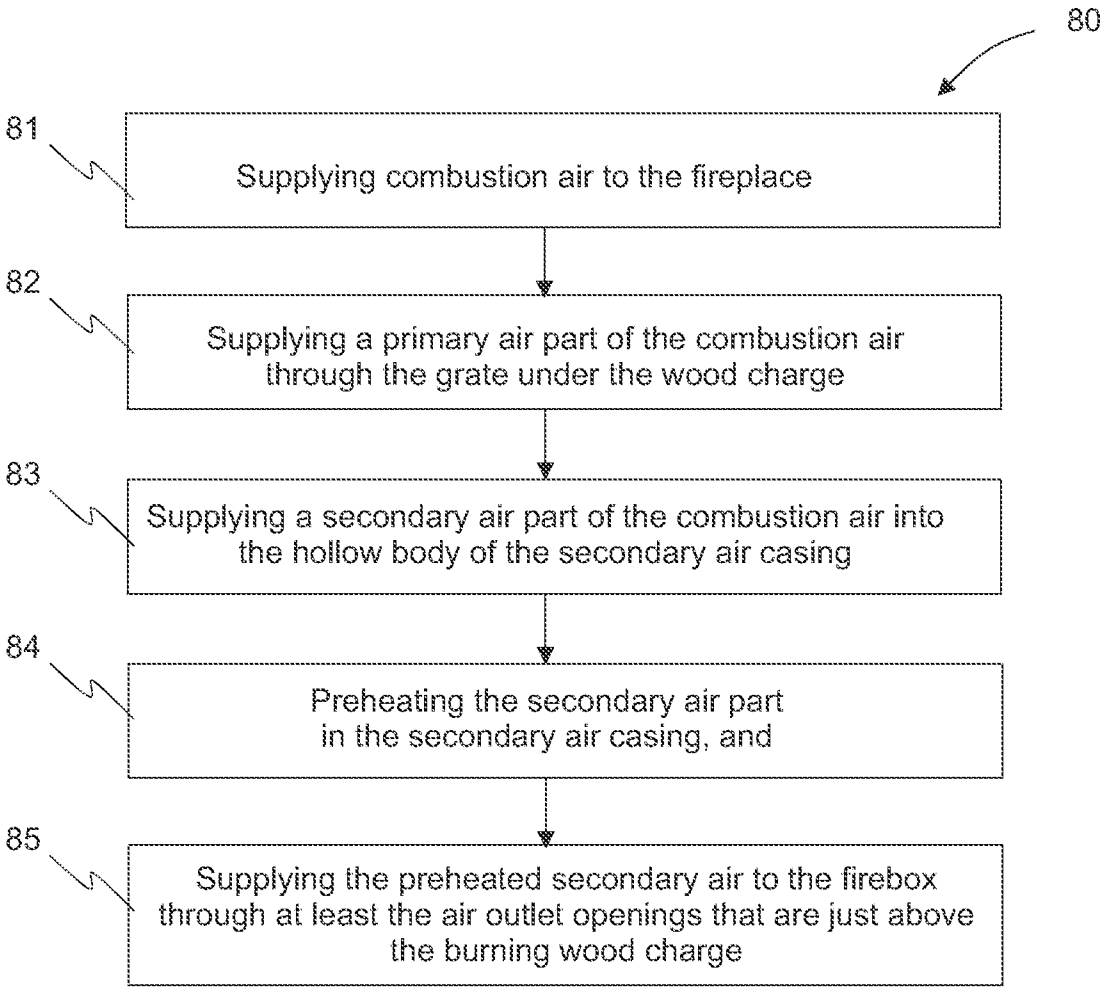

Fig. 8

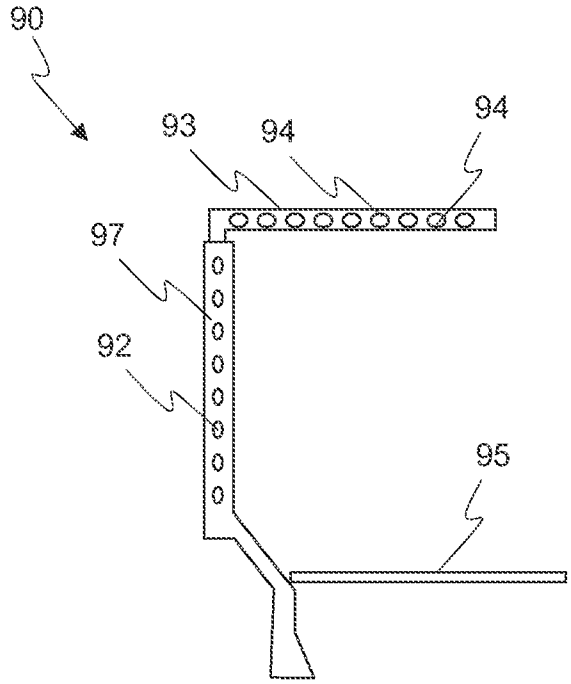

Fig. 9a

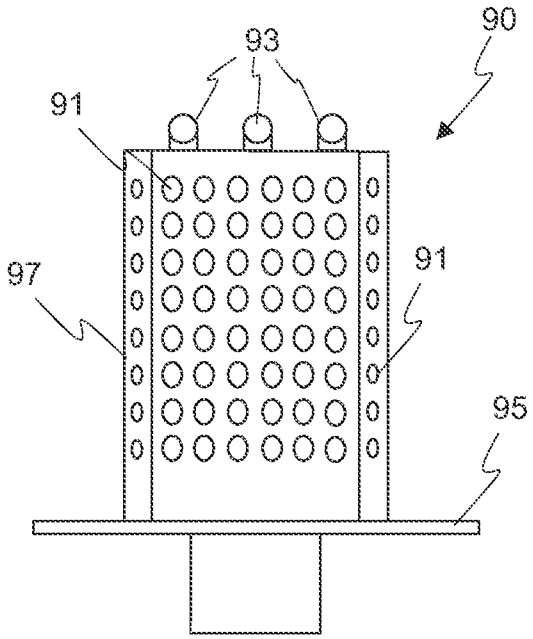

Fig. 9b

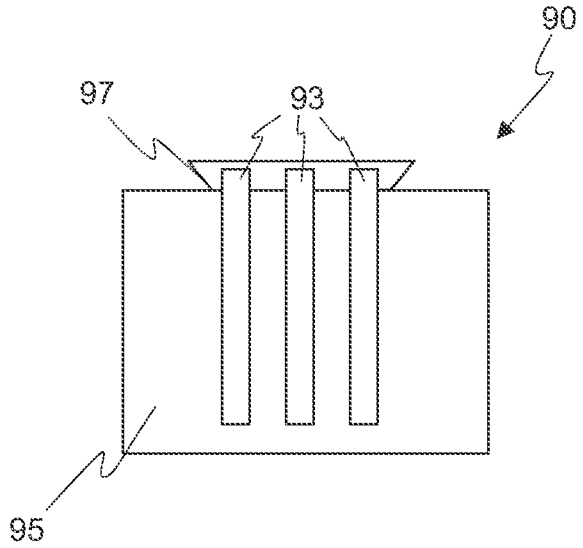

Fig. 9c

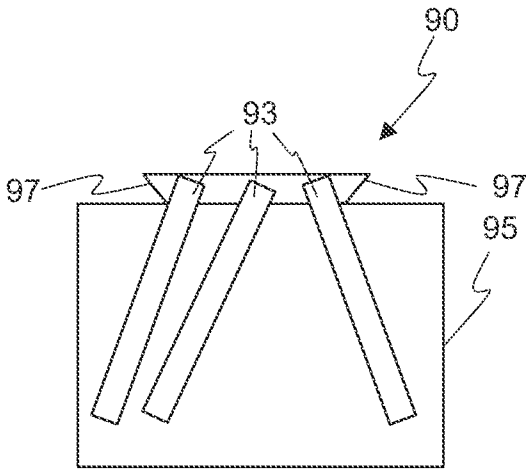

Fig. 9d

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2020/050339

A. **CLASSIFICATION OF SUBJECT MATTER**

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F23L, F24B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPODOC, EPO-Internal full-text databases, WPIAP, Full-text translation databases from Asian languages, PRH-Internal databases

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009003483 A2 (LARSEN JOERGEN FREDERIK [DK]) 08 January 2009 (08.01.2009) page 5, line 21 – page 6, line 25; figures 1-3	1-12
A	WO 2011004072 A1 (NARVI OY [FI]) 13 January 2011 (13.01.2011) page 1, lines 8-12; page 3, lines 28-30; page 4, lines 18-23; page 8, line 20 – page 10, line 10; claims 1, 11 and 12; figures 1-3	1-12
A	CH 235976 A (VON WARTBURG WILHELM [CH]) 15 January 1945 (15.01.1945) page 1, line 45 – page 2, line 35; figures 1 and 2	1-12
A	SU 1182237 A1 (NII SANITARNOJ TEKHNIKI OBORU [SU]) 30 September 1985 (30.09.1985) figures 1-5; abstract [online] EPOQUENET WPI	1-12

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2020 (28.08.2020)	31 August 2020 (31.08.2020)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2020/050339

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016186989 A1 (MINTOFT PETER [GB]) 30 June 2016 (30.06.2016) paragraphs [0037], [0060]-[0065]; figures 1, 2, 4 and 5	1-12

WO 2009003483 A2	08/01/2009	None	
WO 2011004072 A1	13/01/2011	FI 20095782 A	11/01/2011
CH 235976 A	15/01/1945	CH 240716 A	15/01/1946
SU 1182237 A1	30/09/1985	None	
US 2016186989 A1	30/06/2016	US 10480782 B2	19/11/2019
		AU 2014291855 A1	11/02/2016
		AU 2014291855 B2	08/11/2018
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		EP 3022493 B1	01/01/2020
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		GB 201312870 D0	04/09/2013
		WO 2015008036 A2	22/01/2015

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2020/050339

CLASSIFICATION OF SUBJECT MATTER

IPC
F23L 9/02 (2006.01)
F23L 9/06 (2006.01)
F24B 5/02 (2006.01)