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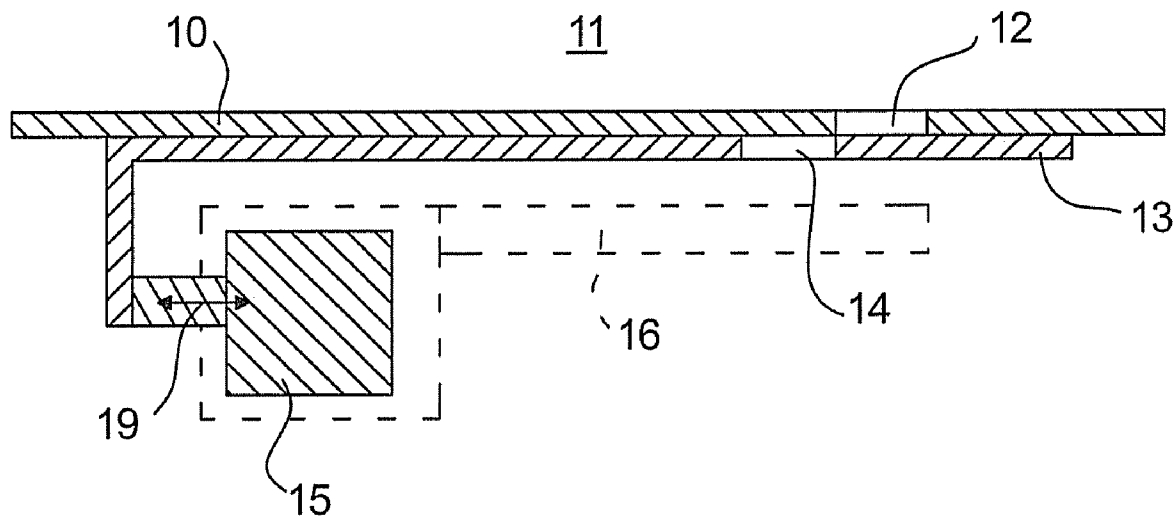
(19) **United States**(12) **Patent Application Publication**
SKOVBO(10) **Pub. No.: US 2009/0260553 A1**(43) **Pub. Date: Oct. 22, 2009**(54) **METHOD AND DEVICE FOR CONTROLLING
THE SUPPLY OF COMBUSTION AIR TO A
COMBUSTION CHAMBER**(75) Inventor: **CHRISTIAN SKOVBO,**
HOJBJERG (DK)Correspondence Address:
CANTOR COLBURN, LLP
20 Church Street, 22nd Floor
Hartford, CT 06103 (US)(73) Assignee: **ADURO A/S, BRABRAND (DK)**(21) Appl. No.: **12/426,707**(22) Filed: **Apr. 20, 2009****Related U.S. Application Data**(63) Continuation of application No. PCT/DK2007/
050150, filed on Oct. 18, 2007.(30) **Foreign Application Priority Data**

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F23N 5/18 (2006.01)(52) **U.S. Cl.** **110/188**(57) **ABSTRACT**

A device is supplying combustion air to a combustion chamber, in which solid fuel is being burned, and the air supply is controlled in accordance with a predetermined program as a function of combustion time. The predetermined program is preferably based on empirical data. The combustion air may be supplied by means of a valve member, which is displaceable between first and second positions, and the valve member may expose varying areas of air supply opening(s) when moved between said positions. Biasing means, such as spring means, may bias the valve member towards said second position and slowing-down means may delay the movement of the valve member.



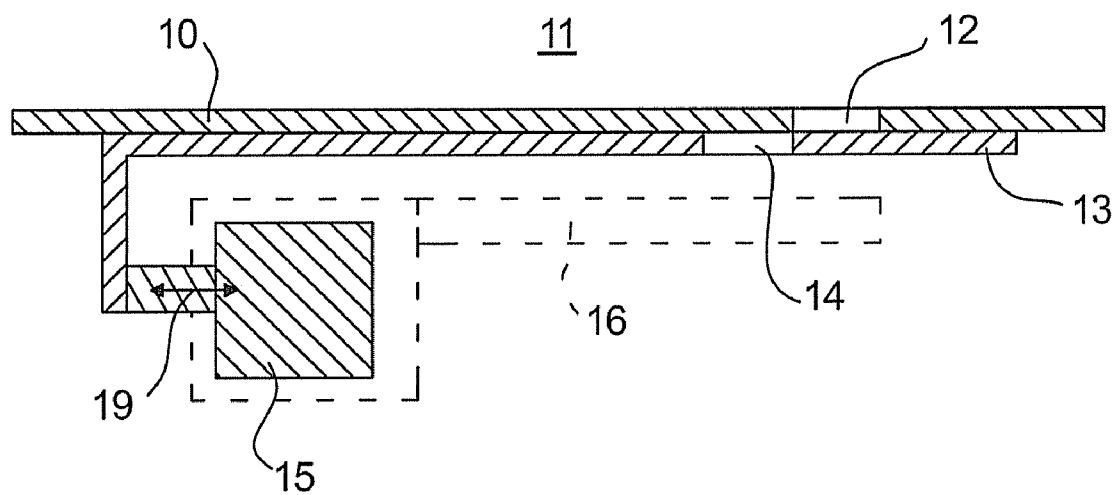


Fig. 1

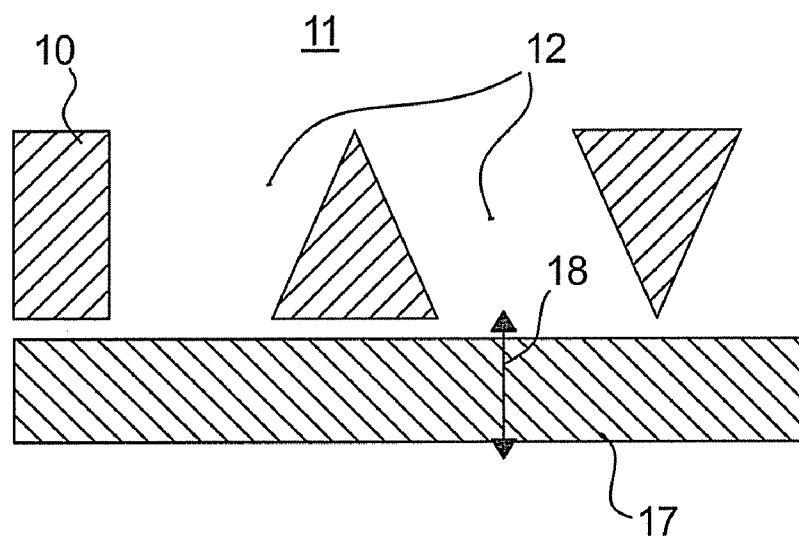


Fig. 2

METHOD AND DEVICE FOR CONTROLLING THE SUPPLY OF COMBUSTION AIR TO A COMBUSTION CHAMBER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of, is related to, and claims the benefit of International Patent Application Number PCT/DK2007/050150 filed on 18 Oct. 2007 which claims priority to Danish Patent Application Number PA 2006 01356 filed on 19 Oct. 2006 and Danish Patent Application Number PA 2007 00940 filed on 28 Jun. 2007, all of which said applications are herein incorporated by reference in their entirety.

BRIEF DISCUSSION OF RELATED ART

[0002] The present invention relates to a method for controlling the supply of combustion air to a combustion chamber, especially for the combustion of solid fuel, such as wood, wood pellets, bales of straw, timber refuse, coal, coke, briquettes, etc.

[0003] The supply of combustion air to a stove or fireplace is often controlled manually. However, it is also known to control the supply of combustion air automatically. Such automatic control may, for example, be based on temperature in the combustion chamber or on the steam pressure in a water jacket located around the combustion chamber of a furnace or boiler. Such known control systems are able to maintain the temperature of the combustion chamber below desired maximum limits. These known methods of controlling combustion air supply do not secure an air supply being optimum for obtaining a clean and complete combustion of the fuel within the combustion chamber.

[0004] When solid fuel is burned in a combustion chamber combustible gases are released from the fuel, but to a higher extent during an initial period than at a later stage of the combustion process. Furthermore, the temperature within the combustion chamber is varying. Therefore, ideally the supply of combustion air to a combustion chamber must be adapted to the varying conditions of the fuel therein.

BRIEF SUMMARY OF THE INVENTION

[0005] The present invention provides a method and a device for supplying combustion air to a combustion chamber such that an improved and substantially complete combustion is obtained.

[0006] Thus, the present invention provides a method for controlling the supply of combustion air to a combustion chamber, in which solid fuel is being burned while combustion air is supplied thereto, and the method according to the invention is characterised in, that the air supply is controlled in accordance with a predetermined program as a function of combustion time.

[0007] In the period of time from the ignition of a charge of solid fuel arranged within a combustion chamber till all of the fuel has been completely burnt the conditions within the combustion chamber are varying substantially. However, because the pattern of such variations is known or may be determined, the need of combustion air supply to the combustion chamber may be determined as a function of time. Thus, said predetermined program is preferably based on empirical data. Such program may be based on certain

assumptions, such as kind and amount of fuel, condition of the fuel, form and size of the combustion chamber etc.

[0008] As mentioned above, more combustible gases are usually released from the solid fuel during the first period than during the later period of a combustion process. Therefore, the amount of combustion air supplied per unit of time is preferably substantially higher at the beginning of the combustion process than at the end of the process. Therefore, control of the air supply in accordance with the predetermined program as a function of combustion time is preferably provided in a manner so as to gradually decrease the air supply during the combustion time. The gradual decrease may be provided at least during at least part of a firing or a refiring period of the combustion time. Hereby a possible advantage is that the combustion or at least firing or refiring of the combustion chamber is provided in an effective manner and any combustion following the firing period may also follow in an effective and also environmentally improved manner.

[0009] The air supply may be decreased three or more times during combustion and when the air supply is controlled in accordance with said predetermined program and only as a function of the combustion time, a simple and yet effective method and device can be provided for improving the combustion. The simple and yet effective method and device preferably only uses the predetermined program and then the time as the only input or variable for controlling the air supply.

[0010] The combustion air may be supplied to the combustion chamber in any suitable controlled manner. As an example the air may be supplied by means of an air blower or fan, and the rotational speed of the blower may be controlled in accordance with said predetermined program. However, presently a mechanically simple solution is preferred. Thus, according to the invention combustion air may be supplied by means of a displaceable valve member, which is displaceable between first and second positions, the valve member exposing varying areas of air supply opening(s) when moved between said positions. The desired variation of air supply may then be obtained by choosing a suitable pattern of openings in the valve member and a by moving the same from said first to said second position from the beginning to the end of the combustion process at a varying or constant rate or speed. It should be understood that the valve member may perform a translational or rotational movement between said first and second positions.

[0011] Said valve member may be a slide valve member and the air supply openings may then be formed in said valve member and/or in an adjacent wall of an air duct or of the combustion chamber, whereby the desired variation in combustion air supply as a function of slide member movement may be obtained. As an example a wedge shaped opening extending in the direction of movement of the valve member may be formed in the said adjacent wall, while an opening in the valve member may expose a varying or increasing area of the wedge shaped opening. The wedge shaped opening may instead be formed in said adjacent wall. Alternatively, a pattern of openings may be present in the valve member and in said adjacent wall such that the coinciding opening area varies as desired when the valve member is moved between said first and second positions.

[0012] The valve member may be biased towards said second position, and the movement of the valve member may then be delayed by slowing-down means. The biasing means

may be of any suitable type, such as a cylinder/piston device with a supply of compressed air, a gas spring, a coil spring or another kind of spring. The slowing-down device may also be selected among a number of conventional slowing-down devices, such as an escapement device, a clockwork, a device in which liquid is forced through a—possibly valve controlled—small opening, etc. Alternatively, the biasing means as well as the slowing-down means could be constituted by clockwork for moving the valve member between said first and second positions at a desired rate or speed.

[0013] According to another aspect the present invention also provides a device for controlling the supply of combustion air to a combustion chamber, and the device according to the invention is characterised in means for controlling the air supply in accordance with a predetermined program as a function of combustion time.

[0014] The said device may comprise a displaceable valve member, which is displaceable between first and second positions, the valve member being adapted to expose varying areas of air supply opening(s) when moved between said positions. The valve member may, for example, be a slide valve member, and the air supply openings may be formed in said valve member and/or in an adjacent wall of an air duct or of the combustion chamber.

[0015] When the displaceable valve member is redirectable or redirected to or at least towards the first position upon opening a combustion chamber door for loading or reloading solid fuel to the combustion chamber, and in particular when the displaceable valve is mechanically connectable or connected to the combustion chamber door, opening of the combustion chamber door may prompt the displaceable valve member to be positioned or repositioned in the first position. Hereby a possible advantage is that the combustion or at least firing or refiring of the combustion chamber is provided in an effective manner and any combustion following the firing period may also follow in an effective and also environmentally improved manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will now be further described with reference to the accompanying drawings, wherein

[0017] FIG. 1 is a diagrammatic sectional view of a first embodiment of the device according to the invention, and

[0018] FIG. 2 is a diagrammatic fragmentary sectional view of a second embodiment of the device according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0019] In the embodiment illustrated in FIG. 1 a bottom wall 10 of a combustion chamber 11 is provided with at least one supply opening 12 for combustion air. A slide valve member 13 is slideably mounted on the bottom surface of the combustion chamber wall 10 so as to cover the air supply opening 12. The valve member 13 has at least one opening 14 formed therein and is slideable between first and second positions in which the supply opening 12 is fully uncovered by the valve member and fully covered (as shown in FIG. 1), respectively. In the position, in which the opening 12 is fully uncovered, the openings 12 and 14 may be aligned.

[0020] A biasing device 15 including a biasing means, a slowing-down means, and a frame 16 is mounted below the combustion chamber wall 10. The biasing means may, for example, be a gas spring, a compressed air cylinder or a coil

spring, and the slowing-down means may, for example, be an escapement device, a clockwork, a device in which liquid is forced through a—possibly valve controlled—small opening.

[0021] When the combustion chamber has been charged with solid fuel and the fuel is ignited, the valve member 13 is positioned in its said first position in which the air supply opening 12 is uncovered so that the supply of combustion air is at its maximum. The biasing means is biasing the valve member 13 towards said second position, in which the air supply opening 12 is substantially covered and closed. The movement of the valve member 13 is delayed by the slowing-down means, and the functions of the biasing means and the slowing-down means are adapted to the openings formed in the chamber wall 10 and the valve member 13 so as to obtain an optimum combustion process. When the valve member has been moved to its second position, it may be reset to its first position automatically or manually.

[0022] The combustion air supplied may be at atmospheric pressure or compressed air, and in the latter case the air pressure may be constant or varying in accordance with a predetermined program. As indicated by an arrow 19 the valve member 13 may be moved under the influence of the biasing and slow-down means such that the movement is substantially constant. Alternatively, the valve member 13 may be moved stepwise in accordance with a predetermined program adapted to the furnace and fuel in question. As an example, the valve member may be retained in its said first position, in which the opening 12 is fully open, for 30 seconds, thereafter 80% of the opening 12 may be uncovered for 2 minutes, 70% of the opening 12 may be uncovered for 4 minutes, 40% of the opening 12 may be uncovered for 5 minutes, 20% of the opening 12 may be uncovered for 8 minutes, whereafter the opening is fully closed.

[0023] The control of the air supply is not exclusively but may be particularly useful when and during firing of the combustion chamber. The combustion chamber may be a combustion chamber in a furnace, stove or fireplace.

[0024] In the embodiment shown in FIG. 2 the slide valve member has been replaced by a damper plate 17, which is movable at right angles to the combustion chamber wall 10 (indicated by an arrow 18) by means of bias means and slow-down means, not shown in FIG. 2.

[0025] It should be understood that various changes and modifications of the embodiments described above may be made within the scope of the accompanying claims. As an example, the slide valve member 13 or damper plate 17 could be moved by an electric motor via transmission means, and the operation of the motor could be controlled by an electronic control device in accordance with a predetermined program. The control device could then have several programs stored therein and the user could then select an appropriate program corresponding to the specific type of fuel and other variable parameters.

1. A method for controlling the supply of combustion air to a combustion chamber (11), in which solid fuel is being burned while combustion air is supplied thereto, the combustion air being supplied by means of a displaceable valve member (13, 17) which is displaceable between first and second positions, the valve member exposing varying areas of air supply opening(s) (12, 14) when moved between said positions

characterised in that,
the valve member (13, 17) is biased towards said second position, where the movement of the valve member is delayed by slowing-down means,
that the air supply is controlled in accordance with a predetermined program as a function of combustion time, and
in that the air supply hereby is gradually decreased during the combustion time.

2. A method according to claim 1, wherein the air supply is decreased three or more times.

3. A method according to claim 1 or 2, wherein the air supply is controlled in accordance with said predetermined program only as a function of the combustion time.

4. A method according to any of claims 1-3, wherein said predetermined program is based on empirical data.

5. A method according to any of claims 1-4, wherein the amount of combustion air supplied per unit of time is substantially higher at the beginning of the combustion process than at the end of the process.

6. A method according to any of the claims 1-5, wherein said valve member is a slide valve member (13), the air supply openings (12, 14) being formed in said valve member and/or in an adjacent wall (10) of an air duct or of the combustion chamber (11).

7. A method according to any of the claims 1-6, wherein the valve member (13, 17) is moved between said positions at a substantially constant rate.

8. A method according to claim 6 or 7, wherein the valve member (13, 17) is moved between said first and second positions by means of clockwork.

9. A device for controlling the supply of combustion air to a combustion chamber (11), the device comprising means (13, 15, 16, 17) for controlling the air supply having a displaceable valve member (13, 17), which is displaceable between first and second positions, the valve mem-

ber being adapted to expose varying areas of air supply opening(s) (12, 14) when moved between said positions, characterised in that

the device comprises biasing means (15), such as spring means, for biasing the valve member (13, 17) towards said second position and slowing-down means for delaying the movement of the valve member,

that the air supply will be controlled in accordance with a predetermined program as a function of combustion time, and

that the air supply hereby will be gradually decreased during the combustion time.

10. A device according to claim 9, wherein the air supply will be decreased three or more times.

11. A device according to claim 9 or 10, wherein the air supply will be controlled in accordance with said predetermined program only as a function of the combustion time during the combustion.

12. A device according to any of the claims 9-11, wherein said valve member is a slide valve member (13), said air supply openings (12, 14) being formed in said valve member (13) and/or in an adjacent wall (10) of an air duct or of the combustion chamber (11).

13. A device according to any of the claims 9-12, comprising means (15, 16) for moving the valve member (13, 17) between said positions at a substantially constant rate.

14. A device according to any of the claims 9-13, comprising clockwork for moving the valve member (13, 17) between said first and second positions.

15. A device according to any of claims 9-14, wherein the displaceable valve member is redirectable to or at least towards the first position upon opening a combustion chamber door for loading or reloading solid fuel to the combustion chamber.

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