(19) Europäisches Patentamt
European Patent Office
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(11) EP 3 825 607 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.05.2021 Bulletin 2021/21

(51) Int Cl.:
F23D 14/04 *(2006.01)*

(21) Application number: **19210642.5**

(22) Date of filing: **21.11.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
KH MA MD TN

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(54) **MODULAR BURNER**

(57) A modular burner, comprising a plurality of mixing modules (10), flanked to each other and parallel to a longitudinal plane (Y), each of which has a length (L) measured parallel to the longitudinal plane (Y), wherein the mixing modules are separated from each other by a mounting pitch (P), measured as the distance between the mean longitudinal planes of two adjacent modules (10). The ratio between the length of the mixing modules (10) and the mounting pitch (P) is about 12.3.

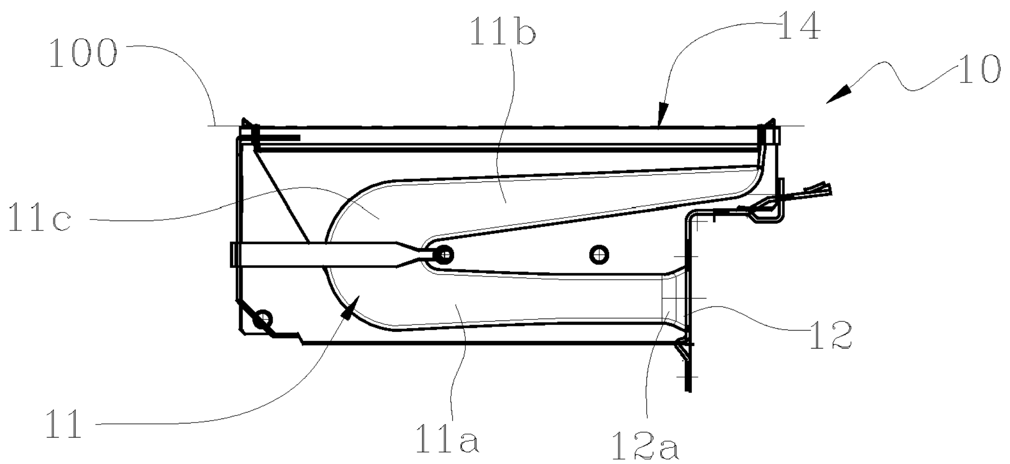

Fig.1

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Description

[0001] The present invention relates to a modular burner, that can be used for example in a wall-mounted boiler.

[0002] In particular, the invention relates to a modular burner comprising a plurality of mixing modules flanked to each other.

[0003] Each mixing module normally comprises a flow conduit of the air-fuel mixture. Such flow conduit is bent in a U shape, i.e. it has a trend comprising two sections slightly inclined to each other and connected by a bend that describes an angle not much less than 180°. The flow conduit lies on a substantially vertical plane. The upper section of the flow conduit is in communication with a set of elongated outlet openings, flanked to each other and arranged on a substantially flat emission surface, which are intended to emit the mixture of air and fuel gas. The emission surfaces of mixing modules lie on a main emission plane of the burner. The lower stretch of the flow conduit of each mixing module faces an injection nozzle of the fuel gas, at a Venturi tube arranged substantially perpendicular to an inlet opening of the flow conduit.

[0004] The flow of fuel gas injected at the inlet of the flow conduit produces the drawing through the Venturi tube of so-called primary air that is mixed with the fuel inside the flow conduit. The air-fuel mixture, which exits from the flow conduit through the outlet openings of the mixing module, feeds a flame which extends above the mixing module, in proximity to the outlet openings themselves. Further combustion air, known as secondary air, is fed to the flame from the surrounding environment, and in particular through the spaces that separate the various flanked mixing modules from each other.

[0005] An important geometric characteristic of modular burners is the ratio between the total area of the burner, taken as the total area of the emission surfaces of the mixing modules and the spaces that separate the emission surfaces themselves, and the total area of the spaces between the emission surfaces of the mixing modules. Both areas are measured on the main emission plane of the burner.

[0006] In current modular burners, the aforesaid ratio is about 0.3. This determines a very consistent contribution of the secondary air for the completion of combustion. At the outlet of the mixing modules through the outlet openings, the air fuel mixture therefore has a relatively low lambda (typically less than 1, i.e. less than the stoichiometric ratio). This means that the flame temperature, in the closer sections to the outlet openings of the mixing modules, is above the critical value for the formation of nitrogen oxides (NOx). This phenomenon is particularly accentuated towards the lower power regimes of the boiler and is certainly undesirable due to obvious reasons of containing harmful emissions.

[0007] The object of the present invention is to offer a modular burner that allows the emission of nitrogen oxide to be reduced.

[0008] An advantage of the burner according to the present invention is that it does not require any particular modifications either to the structure of the wall-mounted boiler in which it is installed, or to the burner itself, which has a substantially similar overall structure to that of the burners currently available.

[0009] Another advantage of the burner according to the present invention is that it enables more precise adjustment of the delivered power.

[0010] Further characteristics and advantages of the present invention will become more apparent in the following detailed description of an embodiment of the present invention, illustrated by way of non-limiting example in the attached figures, wherein:

- figure 1 is a schematic view of a mixing module that can be used in a burner according to the present invention;
- figure 2 schematically shows a boiler in which a burner can be used according to the present invention;
- figures 3 and 4 show respectively a view from the side and from above of a modular burner according to the present invention;
- figure 4a shows the view from above with some significant areas of the burner highlighted;
- figure 5 shows a graph that represents the lambda of the air-fuel mixture as a function of the power regime delivered by the burner in a currently available burner;
- figure 6 shows a graph that represents the lambda of the air-fuel mixture as a function of the power regime delivered by the burner in a burner according to the present invention.

[0011] The modular burner (1) according to the present invention can be used in a boiler of the type schematically illustrated figure 2. The burner (1) produces a flame that heats an overlying heat exchanger (3) inside which a vector fluid circulates which transports the heat received towards envisaged destinations. The fumes produced by combustion are aspirated by means of a fan (4) to be sent to a flue.

[0012] The modular burner according to the present invention comprises a plurality of mixing modules (10) flanked to each other. The mixing modules have a flattened conformation overall and are arranged parallel to each other by means of supports (S) that allow the burner (1) to be constrained to a support structure. The mixing modules (10) are separated from each other by free spaces that allow the passage of air.

[0013] Each mixing module (10) comprises a flow conduit (11), i.e. a conduit for the passage of an air-fuel mixture. In the embodiment represented, the flow conduit (11) has a U-shaped curved trend, in which a lower section (11a) is connected to an upper section (11b) through a bend (11 c). The upper section (11b) can be slightly inclined towards the top of the bend (11c).

[0014] The flow conduit (11) is provided with an inlet opening (12). Such inlet opening (12) is located at the end of the lower section (11a). The inlet opening (12) is intended to receive an envisaged flow rate of fuel emitted by a nozzle (2) that can be located in a frontal position with respect to the inlet opening (12). The flow conduit (11) is further provided with a Venturi tube (12a) located downstream of the inlet opening (12). In a known way, the flow of fuel produced by the nozzle (2), passing through the Venturi tube (12a), generates a depression that produces the aspiration of a certain flow rate of air through the inlet opening (12).

[0015] The flow conduit (11) is further provided with a plurality of outlet openings (13), arranged on an emission surface (14). The outlet openings (13) are afforded through an elongated shaped plate, substantially conformed like a strip, which defines the emission surface (14). In the embodiment represented, visible particularly in figure 4, the outlet openings (13) have an elongated shape and are parallel to each other.

[0016] The mixing modules (10) are arranged so that the emission surfaces (14) lie on an emission plane (100) of the burner. Such emission plane (100) is substantially a plane that contains the emission surfaces (14), apart from any misalignments due to the mounting of the mixing modules (10) and the effective geometry of the emission surfaces (14). In any case, the emission plane (100) contains the geometric projections of the emission surfaces (14).

[0017] On the emission plane (100), the emission surfaces (14) are separated from each other by free surfaces (15). Such free surfaces (15), indicated with cross-hatching in figure 4a, are substantially defined by the geometric projection on the emission plane (100) of the spaces that separate the mixing modules (10). The emission surfaces (14) are instead indicated with inclined hatching.

[0018] In the burner according to the present invention, the operating ratio between total free area, provided by the sum of the free surfaces (15) projected onto the emission plane (100), and the total area of the burner, provided by the sum of the emission surfaces (14) and the free surfaces (15) projected onto the emission plane (100), is less than or equal to 0.2.

[0019] In the modular burners currently available, the operating ratio described above is instead about 0.3. In the modular burner according to the present invention, the operating ratio is therefore less than about 60% of the operating ratio envisaged in the burners currently available.

[0020] In the burner according to the present invention, the ratio between the total area of the outlet openings (13) and the area of the emission surface (14) is greater than 0.35 for each mixing module. For example, the aforesaid ratio is comprised between 0.35 and 0.4 for each mixing module (10).

[0021] Considering that the mixing modules (10) have standard dimensions that envisage a length (L) of 160 mm, in the burner according to the present invention the mixing modules (10) are separated by a mounting pitch (P) of about 13 mm, measured as the distance between the mean longitudinal planes of two adjacent modules (10), while in current burners such pitch is comprised between 17 and 20.5 mm. In the burner according to the present invention, the ratio between the length of the mixing modules (10) and the mounting pitch (P) is greater than 11, while in current burners it is 9.41 maximum. In a particularly advantageous embodiment, such ratio is about 12.3.

[0022] In substance, in the modular burner according to the present invention, the mixing modules (10) are much closer to each other with respect to what is envisaged in current modular burners. This reduces the space that separates the mixing modules (10) from each other, and therefore reduces the free surfaces (15).

[0023] Such a reduction in the operating ratio allows a reduction to the supply of secondary air to the combustion that develops at the outlet of the outlet openings (13), in proximity to the emission surfaces (14) of the emission plane (100). In fact, as already underlined, the mixing modules (10) are separated from each other by very reduced spaces with respect to current burners, so that the free sections (15) available for the flow of secondary air are equally reduced.

[0024] The consistent reduction of the supply of secondary air makes the flow rate of primary air that is aspirated into the flow conduit (11) through the inlet opening (12) predominant. In turn, the flow rate of primary air aspirated into the flow conduit (11) through the inlet opening (12) depends substantially and predominantly on the depression created by the fan (4) inside the boiler, while the effect of the depression created by the flow of fuel transiting through the Venturi tube (12a) becomes substantially negligible. In other words, the flow rate of primary air and the flow rate of secondary air remain substantially constant as the power regime of the boiler varies. After the operating regime of the fan (4) has been established, the power of the burner is adjusted by varying only the flow rate of gas sent to the flow conduit, i.e. by varying the supply pressure of the gas to the nozzle (2). Furthermore, the flow rate of primary air remains substantially constant as the flow rate of fuel sent to the Venturi tube (12a) varies.

[0025] Thanks to the characteristics of the modular burner according to the invention, and in particular thanks to the reduction of the flow rate of secondary air, it is possible to fix the flow rate of primary air that is aspirated into the flow conduit (11) of each mixing module (10) so that the primary lambda of the air-fuel mixture is relatively high, about 1.3, at the low operating powers of the burner (figure 5), and decreases as the power increases until a maximum value of about 0.9 of the burner power. The lambda is equal to 1 at about 85% of the operating power of the burner.

[0026] Thanks to the characteristics of the burner according to the present invention, the primary lambda of the air-fuel mixture is therefore relatively high even from the low operating powers of the burner, therefore also in proximity to the outlet openings (13) and the emission plane (100). This characteristic makes it possible, even from the first combustion steps, to keep the flame temperature below the typical values that cause the formation of nitrogen oxides (NOx).

[0027] In current burners, instead, the cooling of the flame below critical temperatures for the formation of NOx, only takes place following the supply of secondary air, when the nitrogen oxides have already formed in proximity to the emission plane (14).

Claims

1. A modular burner, comprising a plurality of mixing modules (10), alongside each other and parallel to a longitudinal plane (Y), each of which has a length (L) measured parallel to the longitudinal plane (Y), wherein the mixing modules are separated from each other by a mounting pitch (P), measured as the distance between the mean longitudinal planes of two adjacent modules (10), **characterised in that** the ratio between the length of the mixing modules (10) and the mounting pitch (P) is greater than 11.

2. The modular burner according to claim 1, wherein the ratio between the length of the mixing modules (10) and the mounting pitch (P) is about 12.3.

3. The modular burner according to claim 1, wherein each mixing module (10) comprises: a flow conduit (11), equipped with an inlet opening (12) and a plurality of outlet openings (13), arranged on an emission surface (14); wherein the emission surfaces (14) lie on an emission plane (100) of the burner and, on the emission plane (100), the emission surfaces (14) are separated from each other by free surfaces (15); **characterised in that** the ratio between the total area of the free surfaces (15) and the total area of the emission surfaces (14) and of the free surfaces (15) is less than 0.2.

4. The burner according to claim 1, wherein each mixing module (10) comprises: a flow conduit (11), equipped with an inlet opening (12) and a plurality of outlet openings (13), arranged on an emission surface (14); wherein the emission surfaces (14) lie on an emission plane (100) of the burner and, on the emission plane (100), the emission surfaces (14) are separated from each other by free surfaces (15); **characterised in that**, in each mixing module (10), the ratio between the total area of the outlet openings (13) and the area of the emission surface (14) is comprised between 0.35 and 0.4.

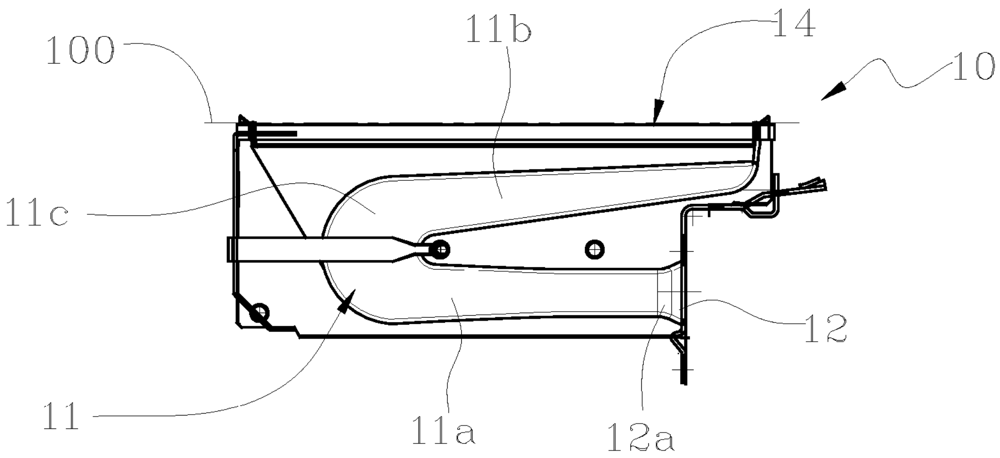


Fig.1

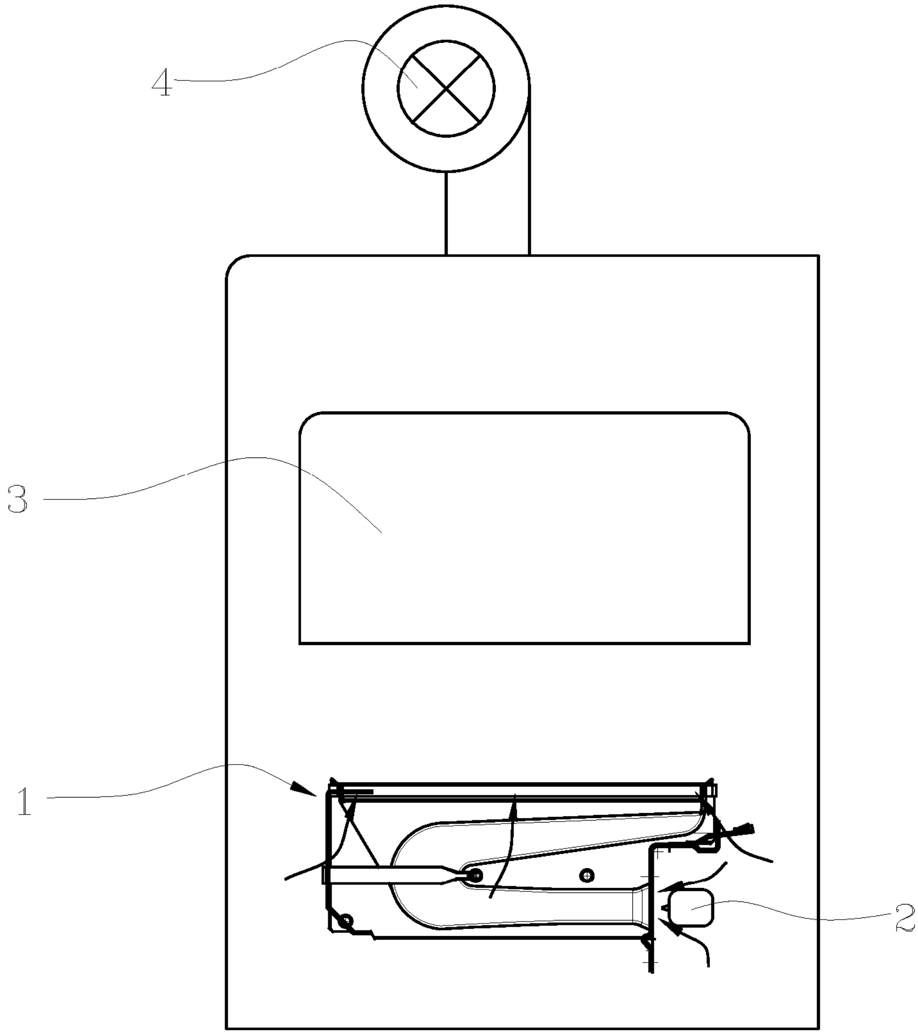
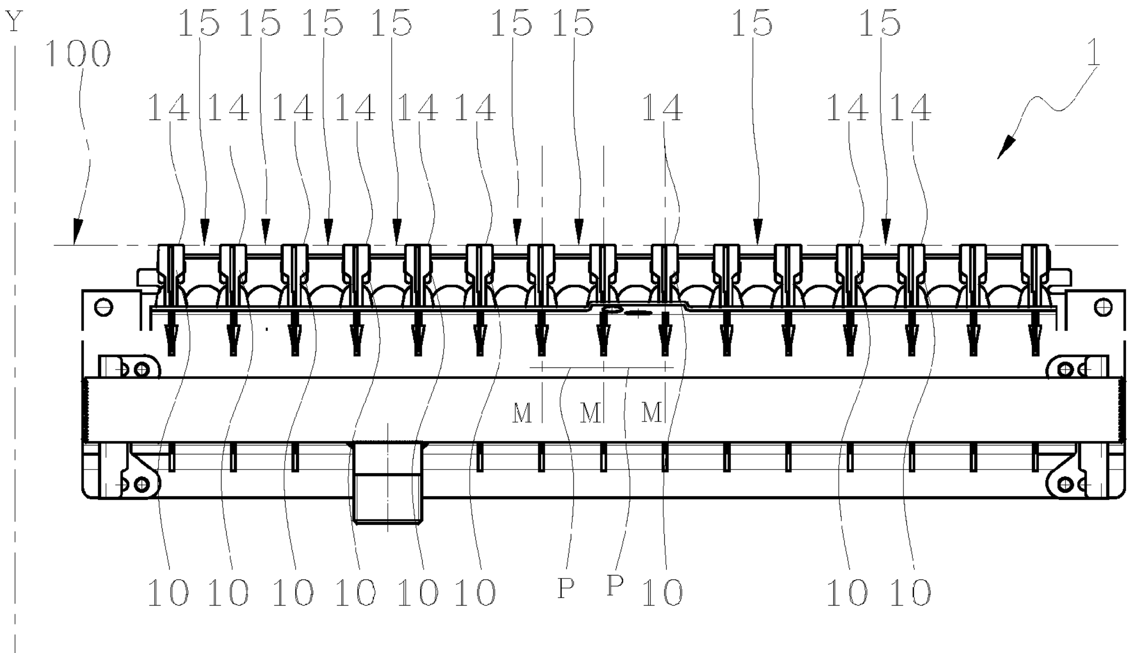


Fig.2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1
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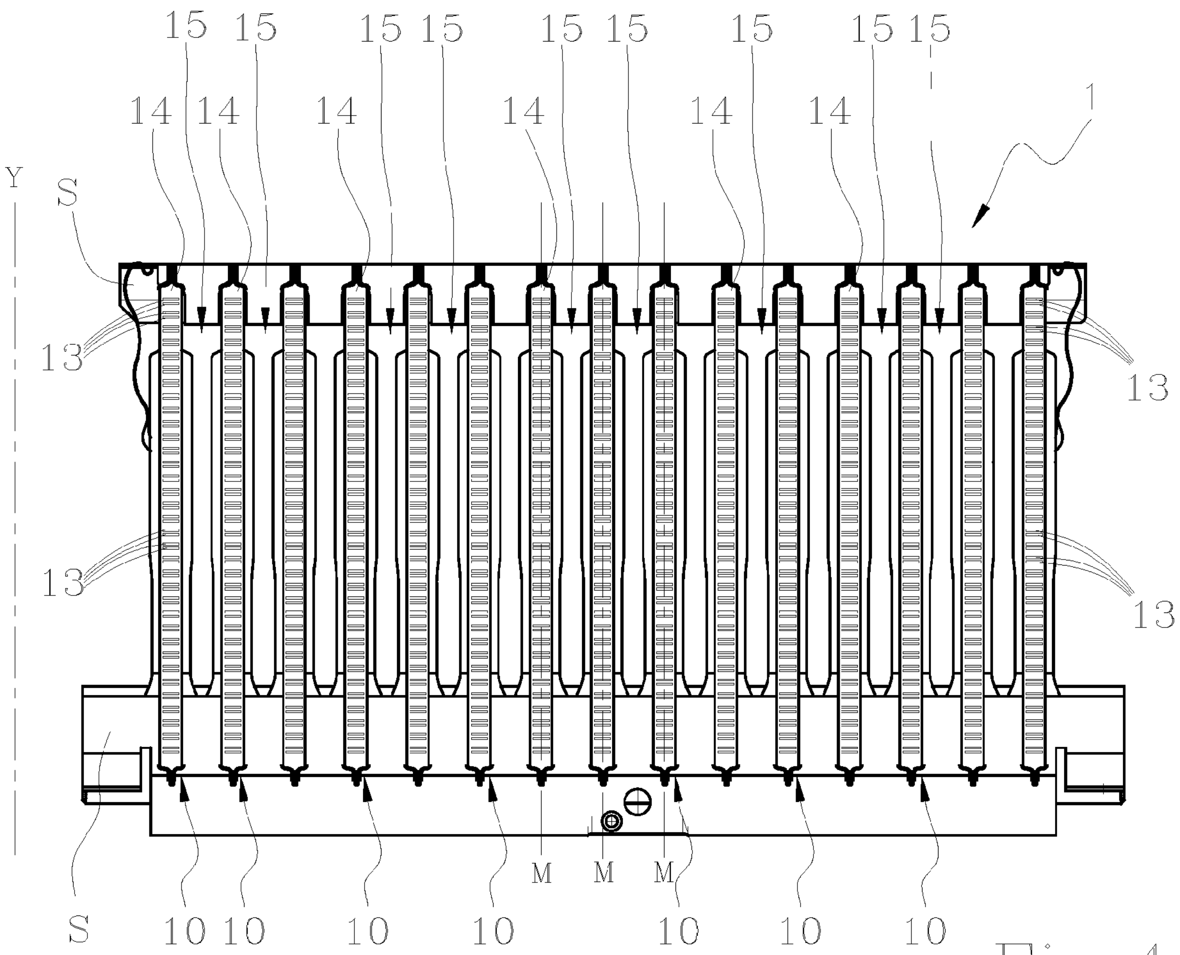
M M M
10 10 10 10 10 10 P P 10 10 10

Fig.3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13
13
M M M
S 10 10 10 10 10 10 10

Fig.4

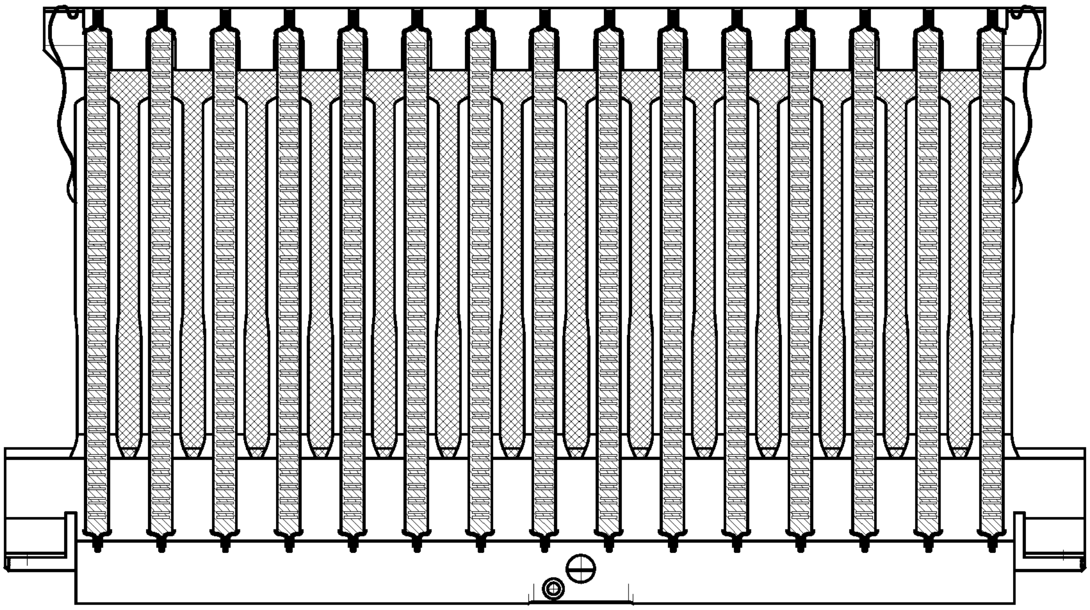
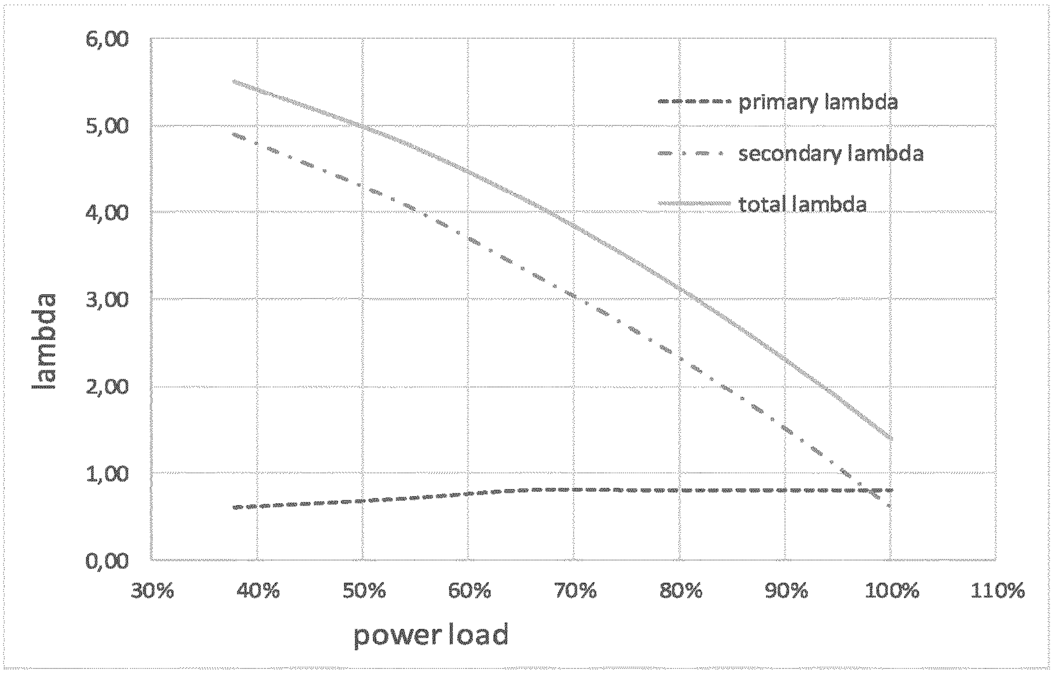


Fig.4a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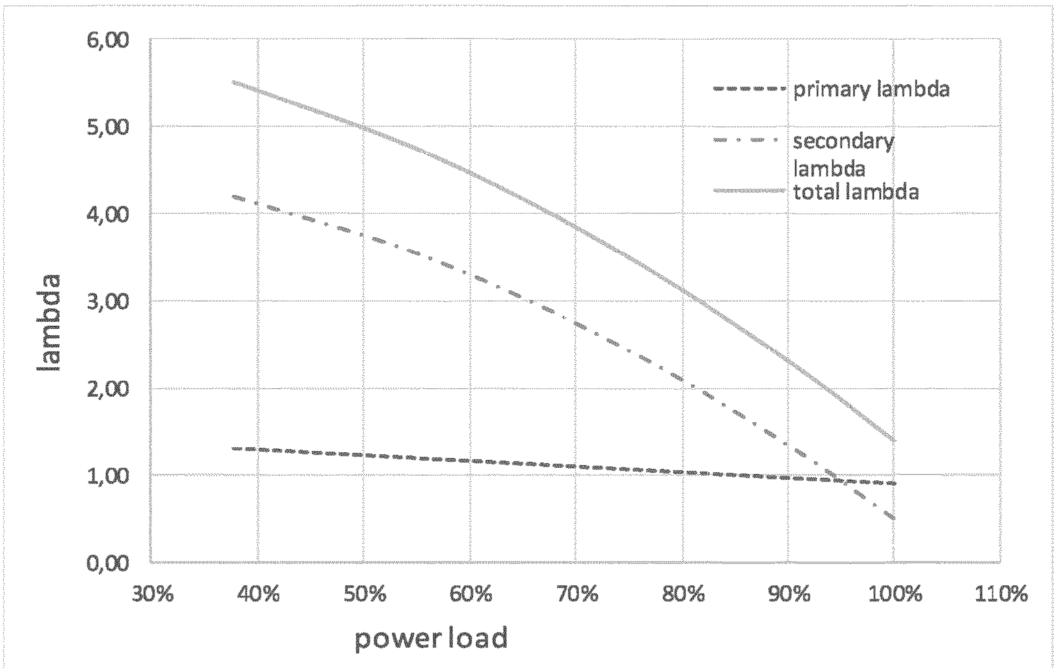
90%
100%
110%
power load
primary lambda
secondary lambda
total lambda

Fig.5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total lambda

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 0642

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 130 315 A2 (BOSCH GMBH ROBERT [DE]) 5 September 2001 (2001-09-05) * paragraph [0008] - paragraph [0016]; figures 1-7 *	1	INV. F23D14/04
A	DE 92 15 726 U1 (JOH. VAILLANT GMBH) 7 January 1993 (1993-01-07) * page 1 - page 5; claim 1; figures 1-6 *	1	
A	EP 0 679 839 A1 (CHAFFOTEAUX ET MAURY [FR]) 2 November 1995 (1995-11-02) * column 4, line 30 - column 7, line 30; figures 1-5 *	4	
A	GB 1 299 458 A (WILLIAM BAILEY BIRMINGHAM LTD) 13 December 1972 (1972-12-13) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)
F23D

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	24 April 2020	Theis, Gilbert

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1130315 A2	05-09-2001	CN 1311413 A	05-09-2001
		DE 10010762 A1	20-09-2001
		DE 50107868 D1	08-12-2005
		EP 1130315 A2	05-09-2001
		ES 2252096 T3	16-05-2006
DE 9215726 U1	07-01-1993	AT 397558 B	25-05-1994
		DE 9215726 U1	07-01-1993
EP 0679839 A1	02-11-1995	EP 0679839 A1	02-11-1995
		FR 2719360 A1	03-11-1995
GB 1299458 A	13-12-1972	NONE	

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