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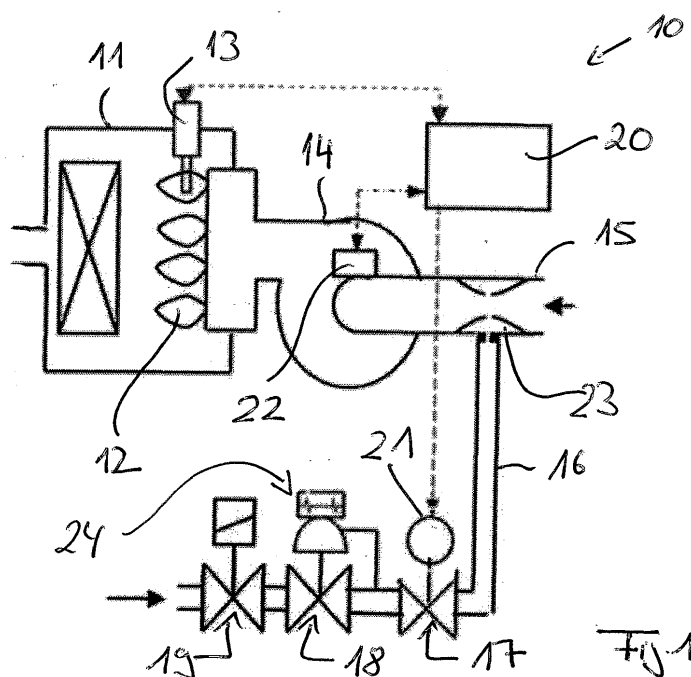
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(54) **Method for operating a gas burner**

(57) Method for operating a gas burner (10), wherein during burner-on phases a defined gas/air mixture having a defined mixing ratio of gas and air is provided to a burner chamber (11) of the gas burner (10) for combusting the defined gas/air mixture within the burner chamber (11), wherein the defined gas/air mixture is provided by a mixing device (23) mixing an air flow provided by an air duct (15) with a gas flow provided by a gas duct (16). During burner-on phases the defined mixing ratio of gas and air of the defined gas/air mixture can be calibrated to differ-

ent gas qualities on basis of a signal provided by an ionization sensor (13) positioned downstream of the mixing device (23) within the burner chamber (11). For the calibration of the gas/air mixture the gas/air mixture is made richer by increasing the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal provided by the ionization sensor (13) is detected, whereby the further calibration of the gas/air mixture depends on if either a flattening or a maximum of the signal provided by the ionization sensor (13) is detected.



Description

[0001] The present patent application relates to a method for operating a gas burner.

[0002] EP 0 833 106 B1 discloses a method for operating a gas burner. According to this prior art document, during burner-on phases of the gas burner a defined gas/air mixture having a defined mixing ratio of gas and air is provided to a burner chamber of the gas burner. The defined gas/air mixture is provided by mixing an air flow provided by an air duct with a gas flow provided by a gas duct. The quantity of the air flow is adjusted by a fan. The defined mixing ratio of the gas/air mixture is controlled by a controller.

[0003] It is further known from EP 0 833 106 B1 that the defined gas/air mixture has to be calibrated to the quality of the gas in order to ensure an optimum and complete combustion of the gas. The quality of the gas is defined by the so-called "Wobbe-Index". EP 0 833 106 B1 discloses a method to calibrate the defined gas/air mixture to different gas qualities depending on a signal provided by an ionization sensor.

[0004] EP 0 962 703 B1 discloses that the calibration of the defined gas/air mixture to different gas qualities on basis of a signal provided by an ionization sensor shall only be performed in a range close to full-load operation of the gas burner, whereby the range close to full full-load operation lies between 60% and 100% of full full-load operation of the gas burner.

[0005] EP 1 309 821 B1 discloses that the calibration of the defined gas/air mixture to different gas qualities on basis of a signal provided by an ionization sensor shall be only performed at selected times, namely immediately after installation of the sensor and/or immediately after restart of the gas burner and/or immediately after a reset.

[0006] DE 10 2008 031 979 A1 discloses a calibration of the defined gas/air mixture to different gas qualities on basis of a signal provided by an ionization sensor, whereby for the calibration during burner-on phases in a first step the gas/air mixture is made leaner by increasing the air amount of the gas/air mixture relative to the gas amount of the same until the gradient of the signal provided by the ionization sensor becomes greater than a threshold, and that afterwards the gas/air mixture is made richer by increasing the gas amount of the gas/air mixture relative to the air amount of the same.

[0007] Against this background, a novel method for operating a gas burner is provided.

[0008] The method for operating a gas burner according to the present application is defined in the claim 1.

[0009] The method according to the present application is directed to the calibration of the defined gas/air mixture to different gas qualities. For the calibration of the gas/air mixture the gas/air mixture is made richer by increasing the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal provided by the ionization sensor is detected. The further calibration depends on if either a flattening or a maximum of the signal provided by the ionization sensor is detected. The present application teaches to distinguish between a flattening detection and a maximum detection of the signal provided by the ionization sensor. Such a differentiation between the flattening detection and the maximum detection provides an improved calibration of the defined gas/air mixture to different gas qualities.

[0010] According to a preferred embodiment, the air flow provided by the air duct depends on a fan speed of a fan assigned to the air duct or the burner chamber, and the gas flow provided the gas duct depends on a position of at least one gas valve assigned to the gas duct. For calibration of the gas/air mixture, the throttle position of a throttle assigned to the gas duct or to the mixing device is preferably continuously changed in order to continuously increase the gas flow while keeping the fan speed and the air flow constant thereby continuously increasing the gas amount of the gas/air mixture relative to the air amount of the same. The signal provided by the ionization sensor is continuously monitored and analyzed while the gas amount of the gas/air mixture becomes continuously increased relative to the air amount of the same. The calibration of the gas/air mixture depends on a reference throttle position of the throttle for which a flattening or a maximum of the signal provided by the ionization sensor is detected. The calibration further depends on an offset value added to the reference throttle position for which the flattening or the maximum is detected, whereby the offset value depends on if either a flattening or a maximum of the signal provided by the ionization sensor is detected. The offset value is preferably determined on basis of a characteristic curve or on basis of a formula, whereby a first characteristic curve or a first formula is used when a flattening of the signal provided by the ionization sensor is detected, and whereby a second characteristic curve or a second formula being different from the first characteristic curve or first formula is used when a maximum of the signal provided by the ionization sensor is detected. Such a calibration is simple and reliable.

[0011] Only the calibration of the defined gas/air mixture depends on the signal provided by the ionization sensor. The control of the defined gas/air mixture as such over the modulation range of the gas burner is independent from the signal provided by the ionization sensor.

[0012] The present application further relates to a controller of a gas burner having means for performing the method according to the present application. Preferred developments of the invention are provided by the dependent claims and the description which follows. Exemplary embodiments are explained in more detail on the basis of the drawing, in which:

Figure 1 shows a schematic view of a gas burner;

Figure 2 shows a diagram illustrating the present invention; and

Figure 3 shows an additional diagram further illustrating the present invention.

[0013] Figure 1 shows a schematic view of a gas burner 10. The gas burner comprises a burner chamber 11 in which combustion of a defined gas/air mixture having a defined mixing ratio of gas and air takes place during burner-on phases of the gas burner 10. The combustion of the gas/air mixture results into flames 12 monitored by an ionization sensor 13.

[0014] The defined gas/air mixture is provided to the burner chamber 11 of the gas burner 10 by mixing an air flow with a gas flow. A fan 14 sucks in air flowing through an air duct 15 and gas flowing through a gas duct 16. A gas regulating valve 18 for adjusting the gas flow through the gas duct 16 and a gas safety valve 19 are assigned to the gas duct 16.

[0015] The defined gas/air mixture having the defined mixing ratio of gas and air is provided to the burner chamber 11 of the gas burner 10. The defined gas/air mixture is provided by mixing the air flow provided by an air duct 15 with a gas flow provided by a gas duct 16. The air flow and the gas flow become preferably mixed by a mixing device 23. Such a mixing device can be designed as a so-called Venturi nozzle.

[0016] The quantity of the air flow and thereby the quantity of the gas/air mixture flow is adjusted by the fan 14, namely by the speed of the fan 14. The fan speed can be adjusted by an actuator 22 of the fan 14.

[0017] The fan speed of the fan 14 is controlled by a controller 20 generating a control variable for the actuator 22 of the fan 14.

[0018] The defined mixing ratio of the defined gas/air mixture is controlled by the gas regulating valve 18, namely by a pneumatic controller 24 of the same. The pneumatic controller 24 of the gas regulating valve 18 controls the opening/closing position of the gas valve 18. The position of the gas valve 18 is adjusted by the pneumatic controller 24 on basis of a pressure difference between the gas pressure of the gas flow in the gas pipe 16 and a reference pressure. The gas regulating valve 18 is controlled by the pneumatic controller 24 in such a way that at the outlet of the gas valve 18 the pressure is equal to the reference pressure.

[0019] In Figure 1, the ambient pressure serves as reference pressure. However, it is also possible to use the air pressure of the air flow in the air duct 15 as reference pressure. The pressure difference between the gas pressure and the reference pressure is determined pneumatically by pneumatic sensor of the pneumatic controller 24.

[0020] Alternatively, it is possible to determine the pressure difference between the gas pressure of the gas flow in the gas pipe and the reference pressure electronically by an electric sensor (not shown). In this case, the gas valve 18 would be controlled by an electronic controller, e.g. by the controller 20.

[0021] In any case, the mixing ratio of the defined gas/air mixture is controlled in such a way that over the entire modulation range of the gas burner the defined mixing ratio of the defined gas/air mixture is kept constant. A modulation of "1" means that the fan 14 is operated at maximum fan speed and thereby at full-load of the gas burner 10. A modulation of "5" means that the fan 14 is operated at 20% of the maximum fan speed and a modulation of "10" means that the fan 14 is operated at 10% of the maximum fan speed.

[0022] By changing the fan speed of the fan 14 the load of the gas burner 10 can be adjusted. Over the entire modulation range of the gas burner 10 the defined mixing ratio of the defined gas/air mixture is kept constant.

[0023] As described above, the mixing ratio of the defined gas/air mixture is controlled during burner-on phases so that over the entire modulation range of the gas burner 10 the defined mixing ratio of the gas/air mixture is kept constant. During burner-on phases the defined mixing ratio of gas and air of the defined gas/air mixture can be calibrated to different gas qualities. The calibration is performed by adjusting a position of a throttle 17. The throttle position can be adjusted by an actuator 21 assigned to the throttle 17. The controller 20 controls the actuator 21 and thereby the throttle position of the throttle 17.

[0024] The calibration can be performed at selected times, namely immediately after installation of the sensor and/or immediately after restart of the gas burner and/or immediately after a reset. Alternatively, the calibration can be performed in a modulating range of the gas burner 10 close to full-load operation of the same, e.g. between 50% (corresponds to a modulation of "2") and 100% (corresponds to a modulation of "1") of full full-load operation.

[0025] The calibration is based on a signal provided by the ionization sensor 13 positioned downstream of the mixing device 23 within the burner chamber 11. The present application is related to a unique calibration method for calibrating the gas/air mixture to different gas qualities.

[0026] For the calibration of the gas/air mixture the same is made richer by increasing the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal provided by the ionization sensor 13 is detected. The arrow 25 in Figure 2 illustrates that the gas/air mixture is made richer. The further calibration of the gas/air mixture depends on if either a flattening or a maximum of the signal provided by the ionization sensor 13 is detected. This will be described in greater detail below referring to Figures 2, 3. Figure 2 illustrates the dependence of the signal I provided by the ionization sensor 13 from the throttle position X_{17} of the throttle 17 assigned to the gas duct 16 used for the calibration. Figure 3 illustrates the dependence of a calibrated throttle position X_{17-CAL} from a reference throttle position X_{17-REF} determined during calibration.

[0027] It has to be noted that in the shown embodiment the throttle 17 which is used for the calibration is assigned to

the gas duct 16. However, it should be understood that the throttle 17 which is used for the calibration can alternatively be assigned to the mixing device 23.

[0028] For the calibration of the gas/air mixture the throttle position X_{17} is changed through the actuator 21 and the controller 20 in order to increase the gas flow while keeping the fan speed and the air flow constant thereby increasing the gas amount of the gas/air mixture relative to the air amount of the same (see arrow 25 in Figure 2). The throttle position X_{17} is continuously changed in order to continuously increase the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal I provided by the ionization sensor 13 is detected.

[0029] Figure 2 shows a reference throttle position $X_{17-REF (MAX)}$ for which a maximum of the signal I provided by the ionization sensor 13 is detected. Such a maximum can be detected when the signal I provided by the ionization sensor 13 drops by a certain amount while changing the throttle position X_{17} as illustrated by the arrow 26 in Figure 2.

[0030] For further clarification, Figure 2 shows in addition a reference throttle position $X_{17-REF (FLAT)}$ for which a flattening of the signal I provided by the ionization sensor 13 is detected. Such a flattening can be detected when the signal I provided by the ionization sensor 13 remains constant while changing the throttle position X_{17} as illustrated by the bracket 27 in Figure 2.

[0031] Both, the detection of the flattening and the detection of the maximum is performed by the controller 20 and depends on the actual signal I provided by the ionization sensor 13. For some calibrations a flattening of the signal provided by the ionization sensor 13 might be detected and for some other calibrations a maximum of the signal provided by the ionization sensor 13 might be detected.

[0032] When making the gas/air mixture richer, first a flattening of the signal I provided by the ionization sensor 13 might be detectable. The detection of the flattening is preferred. However, if a flattening can not be detected, a maximum of the signal I provided by the ionization sensor 13 can be detected so that the maximum detection serves as a backup or fallback when a flattening detection is not possible.

[0033] When a flattening of the signal I provided by the ionization sensor 13 can be detected, the calibration is based on the flattening detection.

[0034] Only in case a flattening detection is impossible, the calibration is based on the maximum detection.

[0035] The calibration of the gas/air mixture depends on a reference throttle position X_{17-REF} for which a flattening or a maximum of the signal I provided by the ionization sensor 13 is detected. This reference throttle position X_{17-REF} is determined by the controller 20.

[0036] The signal I provided by the ionization sensor 13 is continuously monitored and analyzed by the controller 20 while the gas amount of the gas/air mixture becomes continuously increased relative to the air amount of the same in order to determine a flattening or a maximum of the signal I provided by the ionization sensor 13 and in order to determine the respective reference throttle position X_{17-REF} .

[0037] The calibration further depends on an offset value ΔX_{17} added to the reference throttle position X_{17-REF} for which the maximum or the flattening is detected, whereby the offset value ΔX_{17} depends on if either a flattening or a maximum of the signal I provided by the ionization sensor 13 is detected. This offset value ΔX_{17} is determined by the controller 20.

[0038] The offset value ΔX_{17} is determined on basis of a characteristic curve or on basis of a formula, whereby a first characteristic curve f_{FLAT} or a first formula is used when a flattening of the signal I provided by the ionization sensor 13 is detected, and whereby a second characteristic curve f_{MAX} or a second formula being different from the first characteristic curve f_{FLAT} or the first formula is used when a maximum of the signal I provided by the ionization sensor 13 is detected.

[0039] The first characteristic curve f_{FLAT} or the first formula being valid for a flattening detection differs in such a way from the second characteristic curve f_{MAX} or the second formula being valid for a maximum detection that these curves or formulas output a different offset value ΔX_{17-MAX} or $\Delta X_{17-FLAT}$ for the same or identical reference throttle position X_{17-REF} .

[0040] The reference throttle position X_{17-REF} and the offset value ΔX_{17} added to the reference throttle position X_{17-REF} are used to determine a calibrated throttle position X_{17-CAL} . At the calibrated throttle position X_{17-CAL} the defined gas/air mixture is calibrated to the actual gas quality of the calibration. After calibration the throttle position is adjusted by the controller 20 to the calibrated throttle position X_{17-CAL} .

[0041] When a flattening of the of the signal I provided by the ionization sensor 13 is detected, the calibrated throttle position X_{17-CAL} depends on the respective reference throttle position $X_{17-REF (FLAT)}$ and the respective offset value $\Delta X_{17-FLAT}$ determined on basis of the first characteristic curve f_{FLAT} or the first formula as follows:

$$X_{17-CAL} = X_{17-REF (FLAT)} + \Delta X_{17-FLAT}$$

[0042] When a flattening can not be detected but a maximum of the of the signal I provided by the ionization sensor

13 is detected, the calibrated throttle position X_{17-CAL} depends on the respective reference throttle position $X_{17-REF (MAX)}$ and the respective offset value ΔX_{17-MAX} determined on basis of the second characteristic curve f_{MAX} or the second formula as follows:

$$X_{17-CAL} = X_{17-REF (MAX)} + \Delta X_{17-MAX}$$

[0043] The invention uses a reference throttle position for calibration, whereby the invention distinguishes between a reference throttle position for a detected flattening of the signal I provided by the ionization sensor 13 and a reference throttle position for a detected maximum of the signal I provided by the ionization sensor 13.

[0044] The controller 20 receives and analyses the signal provided by the ionization sensor 13. The controller 20 determines either a flattening or a maximum of the signal provided by the ionization sensor 13. The flattening detection is preferred. The maximum detection serves as a fallback or backup when a flattening can not be detected.

[0045] The controller 20 further determines the respective reference throttle position and respective offset value, whereby these values depend on if either a flattening or a maximum of the signal provided by the ionization sensor 13 is detected.

[0046] On basis of the respective reference throttle position and respective offset value the controller 20 determines calibrated throttle position for the calibration throttle 17.

List of reference signs

[0047]

10 gas burner

11 burner chamber

12 flame

13 ionization sensor

14 fan

15 air duct

16 gas duct

17 throttle

18 gas valve / regulating valve

19 gas valve / safety valve

20 controller

21 actuator

22 actuator

23 mixing device

24 pneumatic controller

25 arrow

26 arrow

27 bracket

5

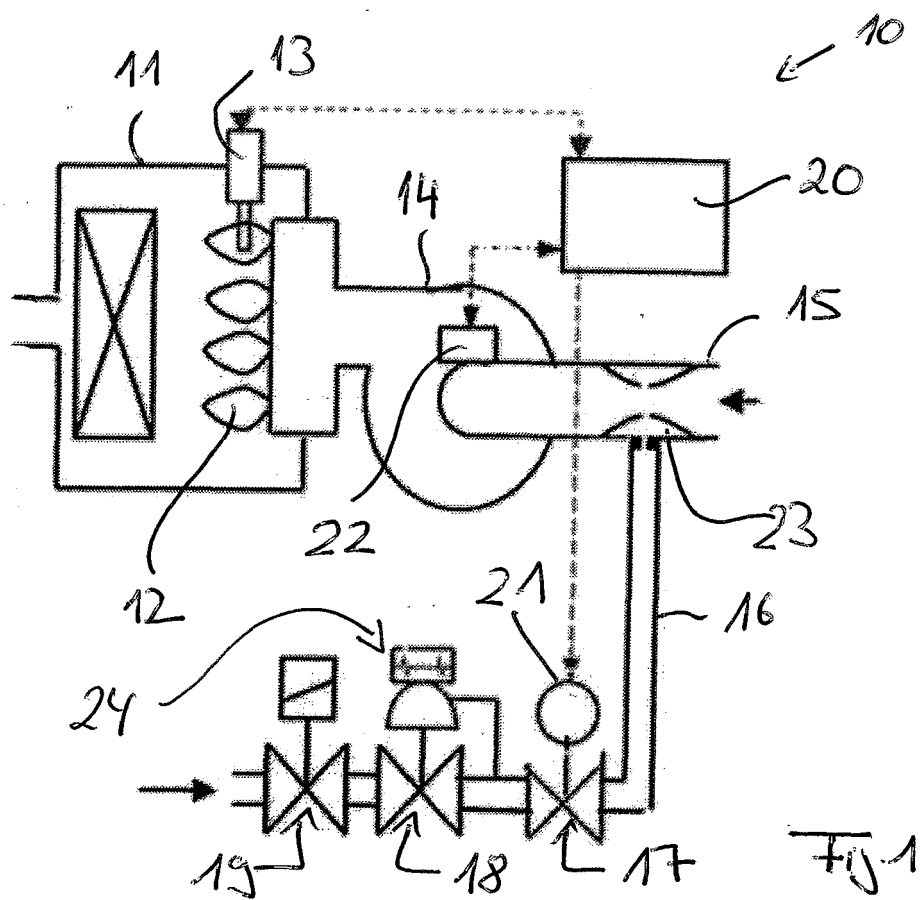
Claims

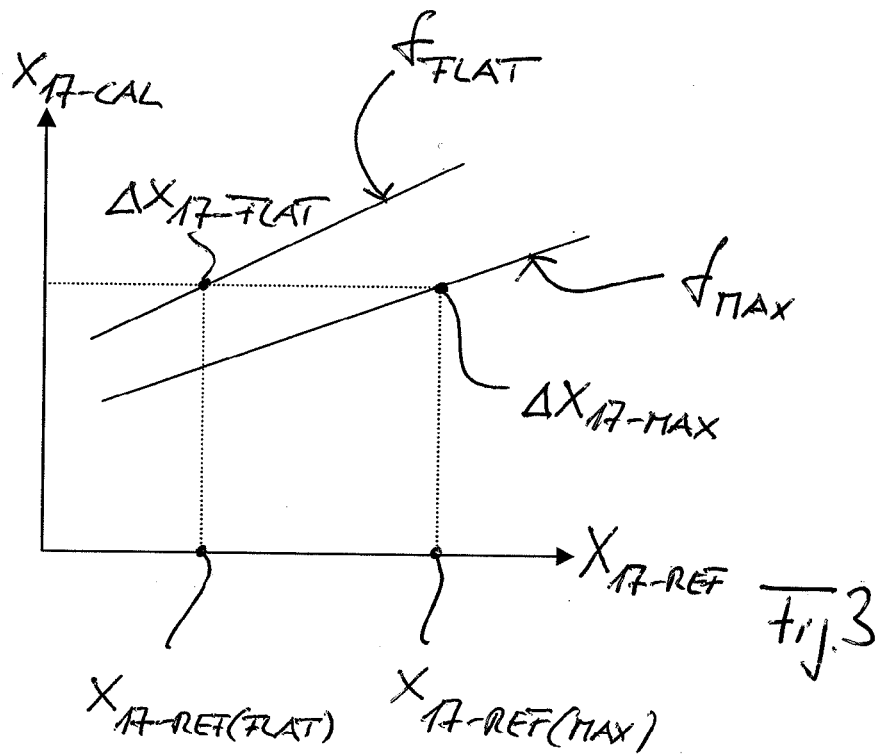
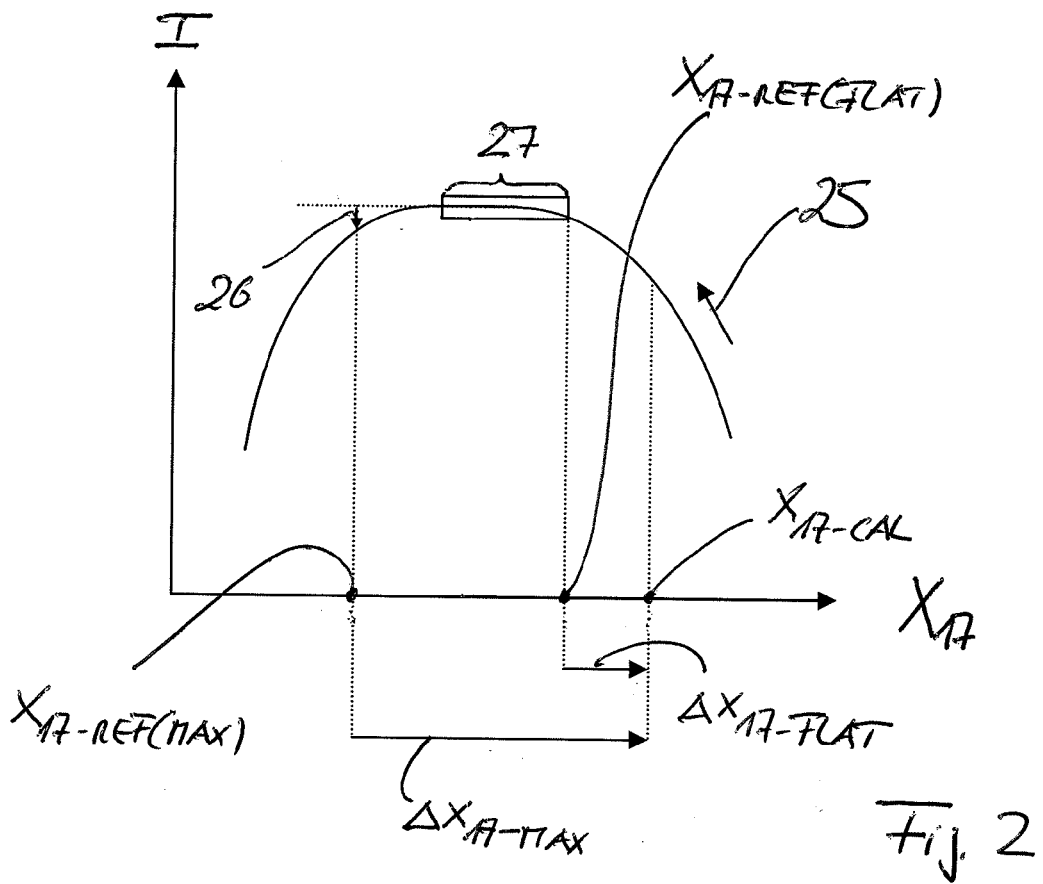
1. Method for operating a gas burner (10), wherein during burner-on phases a defined gas/air mixture having a defined mixing ratio of gas and air is provided to a burner chamber (11) of the gas burner (10) for combusting the defined gas/air mixture within the burner chamber (11), wherein the defined gas/air mixture is provided by a mixing device (23) mixing an air flow provided by an air duct (15) with a gas flow provided by a gas duct (16), and wherein during burner-on phases the defined mixing ratio of gas and air of the defined gas/air mixture can be calibrated to different gas qualities on basis of a signal provided by an ionization sensor (13) positioned downstream of the mixing device (23) within the burner chamber (11), **characterized in that** for the calibration of the gas/air mixture the gas/air mixture is made richer by increasing the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal provided by the ionization sensor (13) is detected, and that the further calibration of the gas/air mixture depends on if either a flattening or a maximum of the signal provided by the ionization sensor (13) is detected.
2. Method as claimed in claim 1, **characterized in that** the air flow provided by the air duct (15) depends on a fan speed of a fan (14) assigned to the air duct (16) or the burner chamber (11), that the gas flow provided the gas duct (16) depends on a position of at least one gas valve (18, 19) assigned to the gas duct (16), and that for calibration of the gas/air mixture a throttle position of a throttle (17) assigned to the gas duct (16) or to the mixing device (23) is changed in order to increase the gas flow while keeping the fan speed and the air flow constant thereby increasing the gas amount of the gas/air mixture relative to the air amount of the same.
3. Method as claimed in claim 2, **characterized in that** that for calibration of the gas/air mixture the throttle position is continuously changed in order to continuously increase the gas amount of the gas/air mixture relative to the air amount of the same until a flattening or a maximum of the signal provided by the ionization sensor (13) is detected.
4. Method as claimed in claim 2 or 3, **characterized in that** the calibration of the gas/air mixture depends on a reference throttle position for which a flattening or a maximum of the signal provided by the ionization sensor (13) is detected, and that the calibration further depends on an offset value added to the reference throttle position for which the flattening or the maximum is detected, whereby the offset value depends on if either a flattening or a maximum of the signal provided by the ionization sensor (13) is detected.
5. Method as claimed in claim 4, **characterized in that** the offset value is determined on basis on a characteristic curve or on basis of a formula, whereby a first characteristic curve or a first formula is used when a flattening of the signal provided by the ionization sensor (13) is detected, and whereby a second characteristic curve or a second formula being different from the first characteristic curve or the first formula is used when a maximum of the signal provided by the ionization sensor (13) is detected.
6. Method as claimed in claim 5, **characterized in that** the first characteristic curve or the first formula being valid for a flattening detection differs in such a way from the second characteristic curve or the second formula valid for the maximum detection that the curves or formulas output a different offset value for an identical reference throttle position.
7. Method as claimed in one of claims 4 to 6, **characterized in that** the reference throttle position and the offset value added to the reference throttle position are used to determine a calibrated throttle position, whereby at the calibrated throttle position the defined gas/air mixture is calibrated to the actual gas quality of the calibration.
8. Method as claimed in one of claims 1 to 7, **characterized in that** only the calibration of the defined gas/air mixture depends on the signal provided by the ionization sensor (13), whereby the control of the defined gas/air mixture over the modulation range of the gas burner (11) is independent from the signal provided by the ionization sensor (13).
9. Method as claimed in claim 8, **characterized in that** the control of the defined gas/air mixture over the modulation range of the gas burner (11) depends on a pressure difference between the gas pressure of the gas flow in the gas pipe and a reference pressure, whereby either the air pressure of the air flow in the air duct or the ambient pressure

is used as reference pressure.

10. Method as claimed in claim 9, **characterized in that** the pressure difference between the gas pressure of the gas flow in the gas pipe and the reference pressure is determined either pneumatically by pneumatic sensor or electronically by an electric sensor.

11. Controller (20) of a gas burner, comprising means for calibrating the defined gas/air mixture to different gas qualities, **characterized by** means for performing the method as claimed in one of claims 1 to 10.







EUROPEAN SEARCH REPORT

Application Number
EP 12 16 9240

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 806 610 A2 (STIEBEL ELTRON GMBH & CO KG [DE]) 12 November 1997 (1997-11-12)	1-3	INV. F23N1/02 F23N5/12
Y	* column 7, line 11 - column 16, line 17;	4	
A	figures 1-15 *	5-11	

X	DE 196 18 573 C1 (STIEBEL ELTRON GMBH & CO KG [DE]) 26 June 1997 (1997-06-26)	1-3	
Y	* column 1, line 56 - column 5, line 67;	4	
	claim 13; figures 1-6 *		

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	* page 25, line 20 - line 26; figure 12 *		

Y	WO 97/18417 A1 (GAS RES INST INC [US]) 22 May 1997 (1997-05-22)	4	
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			TECHNICAL FIELDS SEARCHED (IPC)
			F23N
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		17 October 2012	Munteh, Louis
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 9240

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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17-10-2012

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