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(54) Method and controller for operating a gas burner

(57) Method for operating a gas burner (10), wherein during burner-on phases a 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 gas/air mixture within the burner chamber (11), wherein the gas/air mixture is provided by mixing an air flow sucked in by a fan (14) with a gas flow, and wherein the defined mixing ratio of the gas/air mixture is controlled by comparing an actual value of a signal provided by an electrical or electronic sensor (23) coupled to a gas duct (16) with a nominal value for the signal provided by the electrical or electronic sensor (23) and by generating a control variable for a gas valve (17) assigned to the gas duct (16) on basis of the control deviation between the actual value and the nominal value. The mixing ratio of the gas/air mixture is changed depending on the speed of the fan (14), whereby for fan speeds being smaller than a lower threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a stable combustion of the gas/air mixture, and whereby for fan speeds being larger than the lower thresholds the mixing ratio of gas and air of the gas/air mixture is freely adjustable as a function of the fan speed.

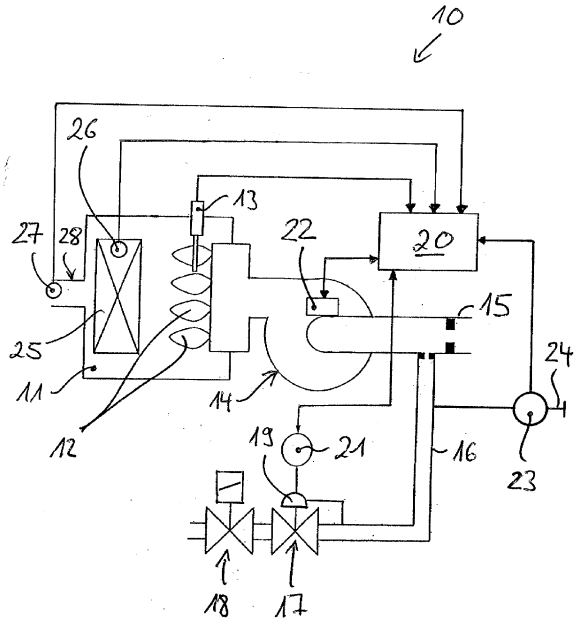

Fig 1

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Description

Method and controller for operating a gas burner

[0001] The present patent application relates to a method for operating a gas burner. Further on, the present patent application relates to a controller for operating a gas burner.

[0002] EP 1 084 369 B1 and EP 1 179 159 B1 each disclose a method for operating a gas burner. According to this prior art documents, during burner-on phases of the respective gas burner a gas/air mixture having a defined mixing ratio of gas and air is provided to a burner chamber of the gas burner. The gas/air mixture is provided by mixing an air flow provided by an air duct with a gas flow provided by a gas duct using a mixing device. 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 on basis of a signal provided by an electrical or electronic sensor. According to EP 1 084 369 B1, the electrical or electronic sensor is coupled to the gas duct and to the air duct. According to EP 1 179 159 B1, the electrical or electronic sensor is coupled to the gas duct and to a reference point. The electrical or electronic sensor is especially designed as a flow-meter. An actual value corresponding to a pressure ratio between the gas pressure in the gas duct and the air pressure in the air duct or corresponding to a pressure ratio between the gas pressure in the gas duct and the air pressure at the reference point is provided by the electrical or electronic sensor, wherein this actual value is compared with a nominal value. A control variable for a gas valve assigned to the gas duct is generated on basis of the control deviation between the actual value and nominal value, wherein the gas valve is adjusted on basis of this control variable in order to provide the defined mixing ratio of gas and air in the gas/air mixture.

[0003] According to EP 1 084 369 B1 and EP 1 179 159 B1, the defined mixing ratio of gas and air of the gas/air mixture is kept constant over the entire modulation range of the gas burner.

[0004] In other words, according to the prior art the mixing ratio of the gas/air mixture is kept constant over the entire fan speed range of the fan, either to provide a 1:1 gas-air control having a ratio between the gas pressure and the air pressure of 1:1 over the entire modulation range of the gas burner or to provide a 1:N (N>1) gas-air control having a ratio between the gas pressure and the air pressure of 1:N over the entire modulation range of the gas burner. In both cases a so-called λ-value is usually greater than 1.

[0005] Against this background, a novel method for operating a gas burner and a novel controller for operating a gas burner are provided.

[0006] The method for operating a gas burner is defined in the claim 1.

[0007] The mixing ratio of the gas/air mixture is changed depending on the speed of the fan, whereby for fan speeds being smaller than a lower threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a stable combustion of the gas/air mixture, and whereby for fan speeds being larger than the lower thresholds the mixing ratio of gas and air of the gas/air mixture is freely adjustable as a function of the fan speed.

[0008] The novel method for operating a gas burner provides over the entire modulation range of the gas burner an optimized mixing ratio of the gas/air mixture. At relative low fan speeds and therefore at the lower end of the modulation range a gas/air mixture is provided having a mixing ratio of gas and air which provides a stable combustion, especially a stable ignition, of the gas/air mixture.

[0009] According to a preferred embodiment, for fan speeds being larger than an upper threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide combustion with reduced emissions.

[0010] Preferably, for fan speeds being larger than the lower thresholds and lower than the upper threshold a gas/air mixture is provided being leaner than the gas/air mixture which is provided for fan speeds being larger than the upper threshold and further being leaner than the gas/air mixture which is provided for fan speeds being smaller than the lower threshold. For fan speeds being smaller than the lower thresholds a gas/air mixture is provided being preferably leaner or alternatively richer than the gas/air mixture which is provided for fan speeds being larger than the upper threshold. It is also possible that for fan speeds being smaller than the lower thresholds a gas/air mixture is provided having the same mixing ratio of gas and air than the gas/air mixture which is provided for fan speeds being larger than the upper threshold. A leaner gas/air mixture has a gas amount being reduced compared to a richer gas/air mixture.

[0011] The controller for operating a gas burner is defined in the claim 13.

[0012] 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.

[0013] Figure 1 shows a schematic view of a gas burner 10. The gas burner 10 comprises a burner chamber 11 in which combustion of a gas/air mixture takes place during burner-on phases of the gas burner 10. The combustion of the gas/air mixture results into flames 12 monitored by e.g. a flame ionization sensor 13. The flame ionization sensor 13 is an optional component of the gas burner 10.

[0014] The 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 though a gas duct 16. A gas valve 17 for adjusting the gas flow through the gas duct 16 and a safety valve 18 are assigned to the gas duct

16. The position of the gas valve 17 is adjusted by a pressure regulator 19.

[0015] The gas/air mixture having a defined mixing ratio of gas and air is provided to the burner chamber 11 of the gas burner 10. The 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. Such a mixing device can be designed as a Venturi nozzle (not shown).

[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 defined mixing ratio of the gas/air mixture is controlled by a controller 20 on basis of a signal provided by an electrical or electronic sensor 23. In the shown embodiment, the electrical or electronic sensor 23 is coupled to the gas duct 16 and to a reference point 24. The electrical or electronic sensor 23 is preferably designed as a flow-meter.

[0018] An actual value corresponding to a pressure ratio between the gas pressure in the gas duct 16 and the air pressure at the reference point 24 is provided by the electrical or electronic sensor 23. This actual value is compared by the controller 20 with a nominal value stored in the controller 20.

[0019] The controller 20 generates a control variable for the gas valve 17, namely for an actuator 21 of the gas valve 17, on basis of the control deviation between the actual value provided by the electrical or electronic sensor 23 and the nominal value stored in the controller 20.

[0020] The gas valve position of the gas valve 17 is adjusted by the actuator 21 of the same on basis of this control variable in order to provide the defined mixing ratio of gas and air in the gas/air mixture.

[0021] According to Figure 1, the flames 12 resulting form the combustion of the gas/air mixture are used to heat a heat exchanger 25 positioned in the burner chamber 11. A temperature sensor 26 is used to measure a temperature of the heat exchanger 25, especially a temperature of water flowing through the heat exchanger 25. The temperature sensor 26 is an optional component of the gas burner 10.

[0022] Exhaust gas resulting from the combustion of the gas/air mixture can exit from the burner chamber 11 though an exhaust pipe 28. An exhaust gas sensor 27 assigned to the exhaust pipe 28 can be used to analyze the emissions of the exhaust gas, especially NOx emissions of the same. The exhaust gas sensor 27 is an optional component of the gas burner 10.

[0023] The mixing ratio of gas and air of the gas/air mixture provided to the burner chamber 11 is not kept constant over the modulation range of the gas burner.

[0024] The mixing ratio of gas and air of the gas/air mixture provided to the burner chamber 11 is changed as a function on the speed of the fan 14.

[0025] For fan speeds of the fan 14 being smaller than a lower threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a stable combustion, especially a stable and secure ignition, of the gas/air mixture. Preferably, for fan speeds being smaller than the lower threshold a gas/air mixture having a mixing ratio of gas and air is provided resulting in a combustion with an almost constant output of the flame ionization sensor 13 or alternatively with an almost constant output of the exhaust gas sensor 27.

[0026] For fan speeds of the fan 14 being larger than an upper threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a combustion with reduced emissions. Preferably, for fan speeds being larger than the upper threshold a gas/air mixture having a mixing ratio of gas and air is provided resulting in a combustion with an output of the exhaust gas sensor 27 being smaller that an emission threshold.

[0027] For fan speeds being larger than the lower thresholds, especially for fan speeds being larger than the lower thresholds and lower than the upper threshold, the mixing ratio of gas and air of the gas/air mixture is freely adjustable as a function of the fan speed of the fan 14. It is possible to use intermediate thresholds between the upper threshold and the lower threshold in order divide this fan speed range into sub-ranges.

[0028] According to a preferred embodiment, for fan speeds of the fan 14 being larger than the lower thresholds and lower than the upper threshold a gas/air mixture is provided being leaner than the gas/air mixture which is provided for fan speeds of the fan 14 being larger than the upper threshold. Further on, for fan speeds of the fan 14 being larger than the lower thresholds and lower than the upper threshold a gas/air mixture is provided being leaner than the gas/air mixture which is provided for fan speeds of the fan 14 being smaller than the lower threshold.

[0029] For fan speeds of the fan 14 being smaller than the lower thresholds a gas/air mixture is provided being preferably leaner than the gas/air mixture of the fan 14 which is provided for fan speeds being larger than the upper threshold. Alternatively, for fan speeds of the fan 14 being smaller than the lower thresholds a gas/air mixture is provided being richer than the gas/air mixture of the fan 14 which is provided for fan speeds being larger than the upper threshold. It is also possible that for fan speeds being smaller than the lower thresholds a gas/air mixture is provided having the same mixing ratio of gas and air than the gas/air mixture which is provided for fan speeds being larger than the upper threshold.

[0030] According to a preferred embodiment, in a first section of the modulation range of the gas burner, namely for fan speeds being larger than the upper threshold, a 1:1 gas-air control having a ratio between the gas pressure and the air pressure of 1:1 is provided. In a second section of the modulation range of the gas burner, namely for fan speeds of the fan 14 being larger than the lower thresholds and lower than the upper threshold, a 1:N (N>1) gas-air control having a ratio between the gas pres-

sure and the air pressure of 1:N is provided. In a third section of the modulation range of the gas burner, namely for fan speeds being smaller than the lower thresholds, a 1:M (N>M>1 or N>M=1 or N>1 >M) gas-air control having a ratio between the gas pressure and the air pressure of 1:M is provided. The second section of the modulation range can be divided into subsections by e.g. intermediate thresholds.

[0031] As a function of on the fan speed of the fan 14 the controller 20 generates an offset value which becomes added to the nominal value for the signal provided by the electrical or electronic sensor 23. Alternatively, as a function on the fan speed of the fan 14 the controller 20 generates an offset value which becomes added to control variable for a gas valve 17.

[0032] The respective offset value which is a function of the fan speed and which is stored in the controller 20 is freely programmable as a function of the fan speed.

[0033] The above variation of the mixing ratio of the gas/air mixture provided to the burner chamber 11 as a function of the speed of the fan 14 is preferably allowed only at defined operating conditions of the gas burner 10.

[0034] If the defined operating conditions of the gas burner 10 are not fulfilled, the controller 20 preferably blocks the above variation of the mixing ratio of the gas/air mixture as a function of the speed of the fan 14.

[0035] According to a first preferred aspect, the variation of the mixing ratio of the gas/air mixture is only allowed if the heat exchanger temperature measured by the temperature sensor 26 is greater than a temperature threshold. If the temperature of the heat exchanger 25 is below the temperature threshold, the defined mixing ratio of gas and air of the gas/air mixture is kept constant over the entire modulation range of the gas burner 10 and thereby over the entire fan speed range of the fan 14. However, if the temperature of the heat exchanger 25 is above the temperature threshold, the defined mixing ratio of gas and air of the gas/air mixture is not kept constant over the modulation range of the gas burner 10. In this case the mixing ratio of gas and air of the gas/air mixture is variable as a function of the fan speed as discussed above.

[0036] According to a second preferred aspect, the variation of the mixing ratio of the gas/air mixture is only allowed if the gas burner 10 has been operated with a defined load for at least a defined time period, especially if the burner load has been greater than a burner load threshold for a time period being greater than a time threshold. If the burner load is below the burner load threshold and/or if the time period is below the time threshold, the defined mixing ratio of gas and air of the gas/air mixture is kept constant over the entire modulation range of the gas burner 10 and thereby over the entire fan speed range. However, if the burner load is above the burner load threshold and if the time period is above the time threshold the defined mixing ratio of gas and air of the gas/air mixture is not kept constant over the modulation range of the gas burner 10. In this case the mixing ratio of gas and air of the gas/air mixture is variable as a function of the fan speed as discussed above.

[0037] According to a third preferred aspect, the variation of the mixing ratio of the gas/air mixture is only allowed if the fan speed is stable, especially if the variation of the fan speed is lower than a variation threshold for a time period being greater than a time threshold. If the variation of the fan speed is above the variation threshold and/or if the time period is below the time threshold, the defined mixing ratio of gas and air of the gas/air mixture is kept constant over the entire modulation range of the gas burner 10 and thereby over the entire fan speed range. However, if the variation of the fan speed is below the variation threshold and if the time period is above the time threshold the defined mixing ratio of gas and air of the gas/air mixture is not kept constant over the modulation range of the gas burner 10. In this case the mixing ratio of gas and air of the gas/air mixture is variable as a function of the fan speed as discussed above.

[0038] It is possible to use two or all three of the above operating conditions in combination. In this case, the above variation of the mixing ratio of the gas/air mixture provided to the burner chamber 11 as a function of the speed of the fan 14 is allowed only if two of the operating conditions or all three of the operating conditions of the gas burner 10 are commonly fulfilled.

[0039] As described above, the controller 20 generates a control variable for the gas valve 17, namely for an actuator 21 of the gas valve 17. The actuator 21 of the gas valve 17 can be a stepper motor.

[0040] At certain times during burner-on phases, especially in fixed time intervals, the controller 20 preferably checks the function of the electrical or electronic sensor 23, especially the gain of the electrical or electronic sensor 23. In order to check the function of the electrical or electronic sensor 23, the controller 17 preferably generates an input variable for the actuator 21 by which the actuator 21 and thereby the gas valve 17 become adjusted by a defined degree or amount. If the actuator 21 is a stepper motor, the controller 20 generates an input variable for the stepper motor by which stepper motor is operated over a defined number of steps.

[0041] The output signal provided by electrical or electronic sensor 23 in response to this operation of the actuator 21 and thereby gas valve 17 is compared by the controller 20 with a nominal output signal expected in response to this operation of the actuator 21.

[0042] If a deviation between actual output signal of the electrical or electronic sensor 23 and the nominal output signal is greater than a threshold, the controller 20 determines an improper function of the electrical or electronic sensor 23, especially a non tolerable change of the sensor gain of the electrical or electronic sensor 23. If the deviation between actual output signal of the electrical or electronic sensor 23 and the nominal output signal is smaller than the threshold, the controller 20 de-

termines a proper function of the electrical or electronic sensor 23, especially a tolerable change of the sensor gain of the electrical or electronic sensor 23 or no change of the sensor gain.

[0043] If the controller 20 determines an improper function of the electrical or electronic sensor 23, especially a non tolerable change of the sensor gain of the electrical or electronic sensor 23, the controller 20 preferably initiates at least one defined action.

[0044] One preferred action initiated by the controller 20 in case the same determines an improper function of the electrical or electronic sensor 23, especially a non tolerable change of the sensor gain, is that the controller 20 blocks the above variation of the mixing ratio of the gas/air mixture provided to the burner chamber 11 as a function of the speed of the fan 14. Only if the controller 20 determines a proper function of the electrical or electronic sensor 23, the controller 20 will allow the variation of the mixing ratio of the gas/air mixture as a function of the speed of the fan 14.

[0045] Other preferred actions initiated by the controller 20 in response to a detected improper function of the electrical or electronic sensor 23 are that the controller 20 generates a service signal indicating that the burner should be inspected by a service person, and/or that the controller 20 performs a calibration for the sensor gain of the electrical or electronic sensor 23, and/or that the controller 20 performs a compensation for the sensor gain shift by a defined offset value, and/or that the gas burner 10 is shut down.

List of reference signs

[0046]

10	gas burner
11	burner chamber
12	flame
13	ionization sensor
14	fan
15	air duct
16	gas duct
17	regulating valve
18	safety valve
19	pressure regulator
20	controller
21	actuator
22	actuator
23	sensor
24	reference point
25	heat exchanger
26	temperature sensor
27	exhaust gas sensor
28	exhaust pipe

Claims

1. Method for operating a gas burner (10), wherein during burner-on phases a 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 gas/air mixture within the burner chamber (11), wherein the gas/air mixture is provided by mixing an air flow sucked in by a fan (14) with a gas flow, and wherein the defined mixing ratio of the gas/air mixture is controlled by comparing an actual value of a signal provided by an electrical or electronic sensor (23) coupled to a gas duct (16) with a nominal value for the signal provided by the electrical or electronic sensor (23) and by generating a control variable for a gas valve (17) assigned to the gas duct (16) on basis of the control deviation between the actual value and the nominal value, **characterized in that** the mixing ratio of the gas/air mixture is changed depending on the speed of the fan (14), whereby for fan speeds being smaller than a lower threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a stable combustion of the gas/air mixture, and whereby for fan speeds being larger than the lower thresholds the mixing ratio of gas and air of the gas/air mixture is freely adjustable as a function of the fan speed.

2. Method as claimed in claim 1, **characterized in that** for fan speeds being smaller than the lower threshold a gas/air mixture is provided having a mixing ratio of gas and air resulting in stable and secure ignition of the gas/air mixture.

3. Method as claimed in claim 1 or 2, **characterized in that** for fan speeds being larger than an upper threshold a gas/air mixture is provided having a mixing ratio of gas and air adapted to provide a combustion with reduced emissions.

4. Method as claimed in claim 3, **characterized in that** for fan speeds being larger than the upper threshold a gas/air mixture is provided having a mixing ratio of gas and air resulting in a combustion with an output of an exhaust gas sensor (27) being smaller that an emission threshold.

5. Method as claimed in claim 3 or 4, **characterized in that** for fan speeds being larger than the lower thresholds and lower than the upper threshold a gas/air mixture is provided being leaner than the gas/air mixture which is provided for fan speeds being larger than the upper threshold.

6. Method as claimed in one of claims 3 to 5, **characterized in that** for fan speeds being larger than the lower thresholds and lower than the upper threshold a gas/air mixture is provided being leaner than the

gas/air mixture which is provided for fan speeds being smaller than the lower threshold.

7. Method as claimed in one of claims 3 to 6, **characterized in that** for fan speeds being smaller than the lower thresholds a gas/air mixture is provided being leaner than the gas/air mixture which is provided for fan speeds being larger than the upper threshold.

8. Method as claimed in one of claims 3 to 6, **characterized in that** for fan speeds being smaller than the lower thresholds a gas/air mixture is provided being richer than the gas/air mixture which is provided for fan speeds being larger than the upper threshold.

9. Method as claimed in one of claims 3 to 6, **characterized in that** for fan speeds being smaller than the lower thresholds a gas/air mixture is provided having the same mixing ratio of gas and air than the gas/air mixture which is provided for fan speeds being larger than the upper threshold.

10. Method as claimed in one of claims 1 to 9, **characterized in that** a controller (20) generates an offset value as a function of the fan speed which becomes added to the nominal value for the signal provided by the electrical or electronic sensor (23).

11. Method as claimed in one of claims 1 to 9, **characterized in that** a controller (20) generates an offset value as a function of the fan speed which becomes added to the control variable for the gas valve (17).

12. Method as claimed in claim 10 or 11, **characterized in that** the offset value is freely programmable as a function of the fan speed.

13. Controller (20) for operating a gas burner (10), namely for controlling of a gas/air mixture which is provided to a burner chamber (11) of the gas burner (10), wherein the controller (20) generates a control variable for a gas valve (17) assigned to a gas duct (16) on basis of a control deviation between an actual value and a nominal value of a signal provided by an electrical or electronic sensor (23) coupled to the gas duct (16), **characterized in that** the controller (20) changes the mixing ratio of gas/air mixture depending on the speed of the fan (14), whereby for fan speeds being smaller than a lower threshold the controller (20) provides a gas/air mixture with a mixing ratio of gas and air adapted to provide a stable combustion of the gas/air mixture, and whereby for fan speeds being larger than the lower thresholds the controller (20) provides a gas/air mixture with mixing ratio of gas and air being freely adjustable as a function of the fan speed.

14. Controller as claimed in claim 13, **characterized by** means for performing the method as claimed in one of claims 1 to 12.

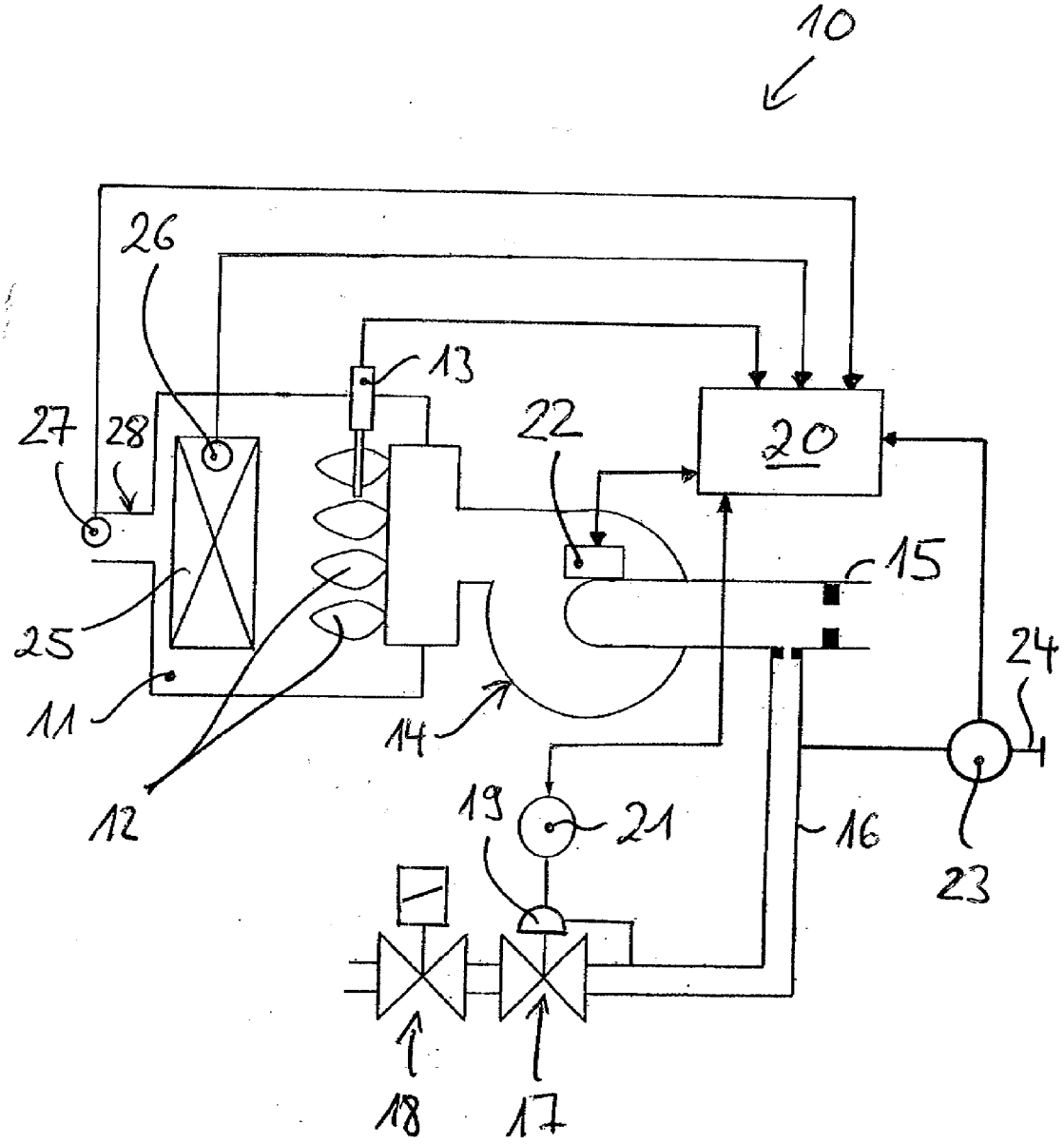

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 6351

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 November 2012	Harder, Sebastian

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 17 6351

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