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(54) METHOD AND CONTROLLER FOR OPERATING A GAS BURNER APPLIANCE

(57) Method for operating a gas burner appliance (10), the gas burner appliance (10) comprising: a combustion chamber (11) in which a defined gas/air mixture is combusted, a mixing device (23) to provide said gas/air mixture, a gas safety valve unit (19) assigned to the gas duct (16) to open or close the gas duct (16) having a first gas safety valve (19a) and a second gas safety valve (19b) positioned downstream of the first gas safety valve (19a), a gas flow modulator (18) assigned to the gas duct (16), an electrical or electronic absolute pressure sensor (21) positioned downstream of the first gas safety valve (19a), wherein the gas burner appliance (10) goes into lockout state if a defined number of burner-start-ups of the gas burner appliance (10) failed, namely did not result into a combustion, and wherein the gas burner appliance (10) is operated by executing the following steps to provide an electrical or electronic pressure-switch functionality: Before each burner-start-up of the gas burner appliance (10) measuring a first absolute pressure by the absolute pressure sensor (21) when the first gas safety valve (19a) is closed. During each burner-start-up of the gas burner appliance (10) measuring a second absolute pressure by the absolute pressure sensor (21) when the first gas safety valve (19a) is opened, determining a pressure difference between the first and second absolute pressure, and comparing the pressure difference with a threshold. A lockout of gas burner appliance (10) is allowed or prevented on basis of the comparison of the pressure difference with the threshold.

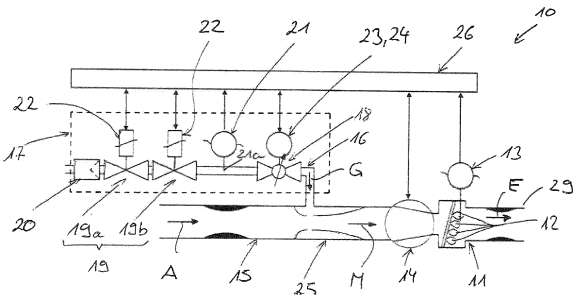

Fig. 1

EP 4 119 845 A1

Description

[0001] The invention relates to a method for operating a gas burner appliance. Further on, the invention relates to a controller for operating a gas burner appliance.

[0002] EP 2 667 097 A1 discloses a method for operating a gas burner appliance. During burner-on-phases in a regular combustion mode of the gas burner appliance, after combustion has been started in connection with a burner-start-up, a gas/air mixture having a defined mixing ratio of gas and air is provided to a combustion chamber for combusting the gas/air mixture. The mixing ratio of gas and air of the gas/air mixture corresponds to the so-called λ-value of the gas/air mixture. The gas/air mixture is provided by a mixing device mixing an air flow provided by an air duct with a gas flow provided by a gas duct. The mixing device may be provided by a Venturi nozzle. The air flow flowing through the air duct is provided by fan in such a way that the nominal fan speed of the fan depends on a nominal burner-load of the gas burner appliance, wherein a fan speed range of the fan defines a so-called modulation range of the gas burner appliance. According to EP 2 667 097 A1, the defined mixing ratio of gas and air and thereby the λ-value of the gas/air mixture is kept constant over the entire modulation range of the gas burner appliance by a pneumatic gas flow regulator. The pneumatic gas flow regulator is provided by a gas armature. In addition to the pneumatic gas flow regulator, the gas armature comprises a safety gas valve and a throttle used for calibration. The pneumatic gas flow regulator uses a pressure difference between the gas pressure of the gas flow in the gas duct and a reference pressure, wherein either the air pressure of the air flow in the air duct or the ambient pressure is used as reference pressure, and wherein the pressure difference between the gas pressure of the gas flow in the gas duct and the reference pressure is determined and controlled pneumatically. EP 2 667 097 A1 discloses a method for operating a gas burner appliance in which the defined mixing ratio of the gas/air mixture is kept constant over the entire modulation range of the gas burner. This is done by the pneumatic gas flow regulator establishing a pneumatic control to keep the mixing ratio of gas and air within the gas/air mixture constant.

[0003] DE 198 24 521 A1 discloses a method to control in a regular combustion mode the mixing ratio of gas and air of the gas/air mixture and thereby the λ-value of the gas/air mixture on basis of a signal provided by an electrical or electronic pressure sensor or flow meter. An actual value corresponding to a pressure ratio between a gas pressure in a gas duct and an air pressure in an 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 the electric gas flow modulator is generated on basis of the control deviation between the actual value and nominal value, wherein the electric gas flow modulator is adjusted on basis of this control variable to control the defined mixing ratio of gas and air in the gas/air mixture thereby keeping the λ-value of the gas/air mixture preferably constant.

[0004] EP 2 998 652 B1 and US 9 074 770 B2 both disclose gas valve units having multiple pressure sensors and temperature sensors. EP 1 000 301 B1 discloses a burner system having a first pressure sensor assigned to an air duct and a second pressure sensor assigned to a gas duct.

[0005] As mentioned above, in a regular combustion mode the amount of the air flow and thereby the amount of the flow of the gas/air mixture having the defined mixing ratio of gas and air provided to the combustion chamber depends on the nominal burner load. The nominal burner-load corresponds to a desired heat demand. The nominal burner-load defines the nominal fan speed at which the fan is operated. The fan speed range of the fan of the gas burner appliance defines the modulation range of the gas burner appliance. A maximum fan speed of the fan defines the maximum burner-load of the gas burner appliance. If a desired heat demand requires maximum burner load, then the fan is operated at maximum fan speed. If a desired heat demand requires burner-load being 50% of the maximum burner load, then the fan is operated at 50% of the maximum fan speed. At any burner load of the gas burner appliance and at any fan speed of the fan the mixing ratio of gas and air of the gas/air mixture is kept at a defined value, preferably constant, either by using an electric gas flow modulator or by using a pneumatic gas flow regulator.

[0006] As also mentioned above, the gas burner appliance needs to execute a burner-start-up in which a provided gas/air mixture having a defined mixing ratio of gas and air is successfully ignited. Only after successfully executing such a burner-start-up and thereby successfully igniting the gas/air mixture, the gas burner appliance can be operated in a regular combustion mode.

[0007] For security reasons, a gas burner appliance goes into lockout state if a defined number of subsequent burner-start-ups of the gas burner appliance failed, namely did not result into a combustion.

[0008] It is possible that a burner-start-up of the burner appliance fails because a gas inlet pressure of the gas burner appliance is too low. If the gas inlet pressure is too low, the gas content within the gas/air mixture is too low to provide an ignitable gas/air mixture. However, a gas burner appliance should not go into lockout state if a burner-start-up failed because of a gas inlet pressure being too low.

[0009] Gas burner appliances known from practical use make use of a mechanical pressure switch to monitor the gas inlet pressure to the gas burner appliance. A mechanical pressure switch may be integrated into gas valves of the gas burner appliance or may be provided as a separate unit of the gas burner appliance. If a mechanical pressure switch measures that a gas inlet pressure is too low, a burner stat-up is not allowed.

[0010] So, by using a mechanical pressure switch it can be avoided that a gas burner appliance goes into lockout state because of a gas inlet pressure being too low. However, such mechanical pressure switches require additional installation space and cause additional hardware costs.

[0011] The method according to the present invention provides an electrical or electronic pressure-switch functionality and eliminates the need of a mechanical pressure switch by executing the following steps:
Before each burner-start-up of the gas burner appliance, measuring a first absolute pressure by the absolute pressure sensor assigned to the gas duct when the first gas safety valve is closed, said first absolute pressure being representative of an ambient pressure.

[0012] During each burner-start-up of the gas burner appliance, measuring a second absolute pressure by the same absolute pressure sensor assigned to the gas duct when the first gas safety valve is opened, said second absolute pressure being representative of a gas pressure, further determining a pressure difference between the first absolute pressure and the second absolute pressure, and further comparing the pressure difference with a threshold.

[0013] A lockout of the gas burner appliance is allowed or prevented on basis of the comparison of the pressure difference with the threshold.

[0014] With the invention it is possible to avoid that a gas burner appliance goes into lockout state because of a gas inlet pressure being too low without the need of a mechanical pressure switch. The method makes use of only one electrical or electronic absolute pressure sensor assigned to the gas duct downstream of a first gas safety valve to measure the above pressures.

[0015] Preferably, during each burner-start-up of the gas burner appliance the second pressure is measured continuously or at a defined sampling rate, further the pressure difference between the first absolute pressure and the second absolute pressure is determined continuously or at the defined sampling rate, and still further the pressure difference is compared with the threshold continuously or at the defined sampling rate. The burner-start-up is terminated if during the respective burner-start-up the pressure difference is below the threshold, wherein the terminated burner-start-up is not considered as a failed burner-start-up. It is possible to avoid that a gas burner appliance goes into lockout state because of a gas inlet pressure being too low without the need of a mechanical pressure switch.

[0016] Preferably, during each burner-start-up of the gas burner appliance it is monitored if the burner-start-up results into a combustion of the gas/air mixture within a defined start-up time interval. If the burner-start-up did not result into a combustion within the defined start-up time interval and if the pressure difference determined during the start-up time interval is below the threshold, then not considering the burner-start-up as a failed burner-start-up. If the burner-start-up did not result into a combustion within the defined start-up time interval and if the pressure difference determined during the start-up time interval is above the threshold, then considering the burner-start-up as a failed burner-start-up. It is possible to avoid that a gas burner appliance goes into lockout state because of a gas inlet pressure being too low without the need of a mechanical pressure switch.

[0017] Preferably, if the first gas safety valve and the second gas safety valve can be opened and closed independently from each other, then measuring also before the burner-start-up of the gas burner appliance the second absolute pressure by the absolute pressure sensor when the first gas safety valve is opened, when the second gas safety valve is closed and when the fan is not running, determining the pressure difference between the first absolute pressure and the second absolute pressure, comparing the pressure difference with the threshold, wherein the burner-start-up is prevented when the pressure difference is below the threshold, and wherein the burner-start-up is allowed when the pressure difference is above the threshold. This is of advantage to prevent a burner-start-up when the pressure difference is below the threshold thereby preventing that gas enters into the combustion chamber which cannot be successfully ignited.

[0018] Preferably, if a burner-start-up without successful ignition of the gas/air mixture has not been considered as a failed burner-start-up due to an insufficient gas inlet pressure, then preventing a new burner-start-up of the gas burner appliance for a defined recheck time interval. Executing again the above steps providing the electrical or electronic pressure-switch functionality after the defined recheck time interval is expired. So, if a burner-start-up did not result into an ignition but has not been considered as a failed burner-start-up, then a new burner-start-up is executed for security reasons only after the defined recheck time interval.

[0019] If a burner-start-up did not result into a successful ignition of the gas/air mixture despite of a sufficient gas inlet pressure, then the burner-start-up without successful ignition is considered as a failed burner-start-up.

[0020] As mentioned above, during each burner-start-up of the gas burner appliance it is monitored if the burner-start-up results into a combustion of the gas/air mixture within a defined start-up time interval. The start-up time interval may also be called safety time interval. This start-up time interval is the maximum time interval for the burner-start-up in which the safety gas valves are opened without detection of a flame. Alternatively, a burner-start-up may be terminated before the end of the defined start-up time interval if it is detected during this start-up time interval that the pressure difference is below the threshold, meaning that the gas inlet pressure is insufficient.

[0021] Preferably, if the burner-start-up results into a combustion within the defined start-up time interval, then measure during a regular combustion mode the second pressure continuously or at a defined sampling rate, determine during the regular combustion mode the pres-

sure difference between the first absolute pressure and the second absolute pressure continuously or at the defined sampling , and compare during the regular combustion mode the pressure difference with the threshold continuously or at the defined sampling rate. If during the regular combustion mode the pressure difference drops below the threshold, then terminate the regular combustion mode. This allows to improve security during regular combustion.

[0022] The controller for operating a gas burner appliance according to the present invention is defined in claim 9.

[0023] Preferred developments of the invention are provided by the dependent claims and the description which follows.

[0024] Exemplary embodiments are explained in more detail on the basis of the drawing, in which:

Figure 1 shows a first gas burner appliance to be controlled by the method and controller of the present invention;

Figure 2 shows a gas armature of a second gas burner appliance to be controlled by the method and controller of the present invention;

Figure 3 shows a third gas burner appliance to be controlled by the method and controller of the present invention;

Figure 4 shows a fourth gas burner appliance to be controlled by the method and controller of the present invention.

[0025] The present invention relates to a method and a controller for operating a gas burner appliance.

[0026] Figure 1 shows a schematic view of a first exemplary gas burner appliance 10. The gas burner appliance 10 comprises a combustion chamber 11 in which combustion of a gas/air mixture M having a defined mixing ratio of gas G and air A takes place during a regular combustion mode of the gas burner appliance 10, namely after a start-up of the gas burner appliance 10 and after successfully igniting the gas/air mixture M. The combustion of the gas/air mixture M results into flames 12 and into exhaust gas E. The flames 12 are monitored by a combustion quality sensor, preferably by a flame ionization sensor 13 providing as output signal an electrical flame ionization current. The flame ionization sensor 13 provides its output signal to a controller 26. The exhaust gas E emanates from the combustion chamber 11 through an exhaust pipe 29.

[0027] The gas/air mixture M is provided to the combustion chamber 11 of the gas burner appliance 10 by mixing a flow of the air A with a flow of the gas G. A fan 14 sucks in air A flowing through an air duct 15 and gas G flowing through a gas duct 16. A gas flow modulator 18 for adjusting the gas flow through the gas duct 16 and a gas safety valve unit 19 having preferably two gas safety valves 19a, 19b are assigned to the gas duct 16.

[0028] The gas flow modulator 18 and the gas safety valves 19a, 19b are part of a gas armature 17 further comprising a sieve 20 and an electrical or electronic absolute pressure sensor 21. The sieve 20 and the electrical or electronic absolute pressure sensor 21 are both assigned to the gas duct 16. The absolute pressure sensor 21 provides its output signal to the controller 26.

[0029] In Figure 1, the electrical or electronic absolute pressure sensor 21, namely the measuring point 21a of the same, is positioned downstream of gas safety valve unit 19, namely downstream of the second gas safety valve 19b. In Figure 1, the electrical or electronic absolute pressure sensor 21, namely the measuring point 21 a of the same, is positioned downstream of gas safety valve unit 19 und upstream of the gas flow modulator 18. The gas armature 17 of Figure 1 can be replaced by the gas armature 17 of Figure 2. In Figure 2, the electrical or electronic absolute pressure sensor 21, namely the measuring point 21a of the same, is positioned downstream of the first gas safety valve 19a of the gas safety valve unit 19 and upstream or the second gas safety valve 19b of the gas safety valve unit 19.

[0030] The gas safety valves 19a, 19b of the gas safety valve unit 19 are operated by electric coils 22 being part of the gas armature 17. In a regular combustion mode the electric coils 22 are energized by the controller 26 to open the gas safety valves 19a, 19b. In burner-off phases the gas safety valves 19 are closed. In Figure 1, each gas safety valve 19a, 19b is operated by one separate electric coil 22. With the use of separate electric coils 22 is possible to open and close the gas safety valves 19a, 19b independently from each other. Alternatively, the gas safety valves 19a, 19b may be operated commonly by a common electric coil 22.

[0031] The gas flow modulator 18 is operated by an actuator 23 also having at least one electric coil 24. In Figure 1, the gas flow modulator 18 is an electric gas flow modulator 18 operated by the controller 26.

[0032] The gas/air mixture M having the defined mixing ratio of gas G and air A is provided to the combustion chamber 11 of the gas burner appliance 10.

[0033] The gas/air mixture M is provided by mixing the air flow A provided by an air duct 15 with a gas flow G provided by a gas duct 16. The air flow and the gas flow become preferably mixed by a mixing device 25. The mixing device 25 may be a venturi nozzle.

[0034] The quantity of the air flow A and thereby the quantity of the gas/air mixture flow M is adjusted by the fan 14, namely by the speed of the fan 14. The fan speed can be adjusted on basis of a nominal burner-load.

[0035] In a regular combustion mode of the gas burner appliance 10, a nominal fan speed of the fan 14 depends on the nominal burner load. The fan 14 is operated by the controller 26. The fan speed range of the fan 14 defines a modulation range of the gas burner appliance 10. In a regular combustion mode of the gas burner appliance 10, a modulation of "1" means that the fan 14 is operated at maximum fan speed (100% of maximum fan speed) and thereby at a full-load of the gas burner appliance 10.

A modulation of "2" means that the fan 14 is operated at 50% of the maximum fan speed and a modulation of "5" means that the fan 14 is operated at 20% of the maximum fan speed. By changing the fan speed of the fan 14, the burner-load of the gas burner appliance 10 can be adjusted.

[0036] In a regular combustion mode of the gas burner appliance 10, the defined mixing ratio of gas G and air A within the gas/air mixture M and thereby the λ-value of the gas/air mixture M is kept at a defined value, preferably constant, over the entire modulation range of the gas burner appliance 10. Said defined mixing ratio of gas G and air A or said λ-value of the gas/air mixture M is controlled over the modulation range of the gas burner appliance using the electric gas flow modulator 18 of a gas armature 17 to keep the defined mixing ratio of gas and air and thereby the λ-value preferably constant over the modulation range of the gas burner appliance. In Figure 1, the control variable for the electric gas flow modulator 18 in order to keep the λ-value constant is generated by the controller 26 on basis of the flame ionization current provided by the flame ionization sensor 13.

[0037] The details described above in connection with Figure 1 fully apply to the modification of Figure 2. Figures 3 and 4 show schematic views of other exemplary gas burner appliances 10' and 10". In Figures 1, 2, 3 and 4 identical reference numbers are used for identical parts. In order to avoid unnecessary repetitions, below only the differences of the gas burner appliances 10, 10' and 10, 10" will be described.

[0038] In Figure 3, during a regular combustion mode the constant mixing ratio of gas G and air A within the gas/air mixture M is controlled by the electric gas flow modulator 18 on basis of a signal provided by an electric or electronic pressure sensor or flow meter 27 and not on basis of the flame ionization current provided by the flame ionization sensor 13. In this case the electric or electronic sensor 27 may provide to the controller 26 an actual value corresponding to a pressure ratio between a gas pressure in a gas duct 16 and an air pressure in an air duct 15 or corresponding to a pressure ratio between the gas pressure in the gas duct 16 and the air pressure at the reference point, wherein the controller 26 may compare said actual value with a nominal value. In this case, the controller 26 may generate the control variable for the electric gas flow modulator 18 on basis of the control deviation between the actual value and the nominal value, wherein the gas flow modulator 18 may be operated on basis of this control variable to keep over the entire modulation range of the gas burner appliance 10 the defined mixing ratio of gas and air and thereby the λ-value constant.

[0039] In Figure 3, the absolute pressure sensor 21 is positioned between the gas safety valve unit 19 and the gas flow modulator 18. Alternatively, the absolute pressure sensor 21, namely the measuring point 21a of the same, may be positioned downstream of the first gas safety valve 19a and upstream of the second gas safety valve 19b.

[0040] In Figure 4, the gas armature 17 comprises a pneumatic gas flow regulator 28. A pneumatic controller 28a of the pneumatic gas flow regulator 28 controls the opening/closing position of the gas regulation valve 28b. The position of the pneumatic gas regulation valve 28b is adjusted by the pneumatic controller 28a on basis of a pressure difference between the gas pressure of the gas flow in the gas duct 16 and a reference pressure. The pneumatic gas regulation valve 28a is controlled by the pneumatic controller 28b in such a way that at the outlet pressure of the gas regulation valve 28b is equal to the reference pressure. In Figure 4, 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. In Figure 4, the pressure difference between the gas pressure and the reference pressure is determined pneumatically a by pneumatic sensor of the pneumatic controller 28a. The mixing ratio of the defined gas/air mixture is controlled by the pneumatic controller 28a in such a way that over the entire modulation range of the gas burner appliance 10 the defined mixing ratio of the gas/air mixture M and thereby the λ-value constant is kept constant.

[0041] In Figure 4, the absolute pressure sensor 21, namely the measuring point 21a of the same, is positioned between the pneumatic gas flow regulator 28 and the mixing device 25. In Figure 4 the gas regulation valve 28b is in its closed position gas tight and acts also as second gas safety valve 19b. If the gas regulation valve 28b is in its closed position not gas tight, there would be separate second gas safety valve 19b and the absolute pressure sensor 21 may then alternatively be positioned between the first gas safety valve unit 19 and the pneumatic gas flow regulator 28 or between the two gas safety valves 19a, 19b.

[0042] The gas burner appliances 10, 10', 10" need to execute a burner-start-up in which a provided gas/air mixture M having a defined mixing ratio of gas G and air A is successfully ignited. Only after successfully executing such a burner-start-up and thereby successfully igniting the gas/air mixture M, the gas burner appliance 10, 10', 10" can be operated in a regular combustion mode.

[0043] Such a burner-start-up has at least an ignition phase and may in addition have a ventilation phase before the ignition phase. The ignition phase may also be called safety phase. During the ventilation phase of the burner-start-up, the gas safety valves 19a, 19b are both closed and the fan 14 is running. During the ignition phase of the burner-start-up, the gas safety valves 19a, 19b are both opened and the fan 14 is running. During the ignition phase an ignition device (not shown) is operated to ignite the gas/air mixture M. The output signal provided by the combustion quality sensor, in Figures 1 and 2 the output signal by the flame ionization sensor 13, may be used to detect if a burner-start-up was successful and resulted into an ignition of the gas/air mixture M.

[0044] For security reasons, the gas burner appliances

10, 10', 10" go into lockout state if a defined number of burner-start-ups failed, namely did not result into a combustion. It is possible that a burner-start-up fails because a gas inlet pressure of the gas burner appliance 10, 10', 10" is too low. If the gas inlet pressure is too low, the gas content within the gas/air mixture M is too low to provide an ignitable gas/air mixture M. However, the gas burner appliance 10, 10', 10" should not go into a lockout state if a burner-start-up failed because of a gas inlet pressure being too low.

[0045] The present invention relates to a method for operating such a gas burner appliance 10, 10', 10", to provide an electrical or electronic pressure-switch functionality thereby securing that the gas burner appliance 10, 10', 10" does not go into a lockout state if a burner-start-up failed because of a gas inlet pressure being too low.

[0046] To provide the electrical or electronic pressure-switch functionality, at least the following steps are executed:

Before each burner-start-up of the gas burner appliance 10, 10', 10", measuring a first absolute pressure by the absolute pressure sensor 21 assigned to the gas duct 16 when the first gas safety valve 19a is closed, said first absolute pressure being representative of an ambient pressure.

[0047] If the absolute pressure sensor 21 is positioned downstream of the first gas safety valve 19a and upstream of the second gas safety valve 19 (see Figure 2), then the first absolute pressure is measured when the first gas safety valve 19b is closed, when the second gas safety valve 19a is opened, when the gas flow modulator 18 being in its closed position not gas tight is opened or closed, and when the fan 14 is not running. In case of Figure 4 having a gas regulation valve 28b being in its closed position gas tight, the gas regulation valve 28b is opened for the measurement of the first absolute pressure.

[0048] If the absolute pressure sensor 21 is positioned downstream of the gas safety valve unit 19, then the first absolute pressure is measured when the first gas safety valve 19a is closed, when second gas safety valve 19b is opened or closed, when the gas flow modulator 18 (Figures 1, 3) being in its closed position not gas tight is opened or closed, and when the fan 14 is not running. In case of Figure 4 having a gas regulation valve 28b being in its closed position gas tight, the gas regulation valve 28b is opened for the measurement of the first absolute pressure.

[0049] During each burner-start-up of the gas burner appliance 10, 10', 10" the following step is executed: Measuring a second absolute pressure by the absolute pressure sensor 21, said second absolute pressure being representative of a gas pressure. During the burner-start-up the second absolute pressure is measured when the first gas safety valve 19a and the second gas safety valve 19b are both opened and when the fan 14 is running. Further, the gas flow modulator 18 or the gas regulation valve 28b is opened during a burner-start-up to provide a gas/air mixture M to the combustion chamber 11.

[0050] During each burner-start-up of the gas burner appliance 10, 10', 10", further the following step is executed: Determining a pressure difference between the first absolute pressure and the second absolute pressure.

[0051] During each burner-start-up of the gas burner appliance 10, 10', 10", further the following step is executed: Comparing the pressure difference with a threshold.

[0052] A lockout of gas burner appliance 10, 10', 10" is allowed or prevented on basis of the comparison of the pressure difference with the threshold.

[0053] During each burner-start-up of the gas burner appliance 10, 10', 10" the second pressure is measured continuously or at a defined sampling rate. Further, during each burner-start-up the pressure difference between the first absolute pressure and the second absolute pressure is determined continuously or at the defined sampling rate. Still further, during each burner-start-up the pressure difference is compared with the threshold continuously or at the defined sampling rate.

[0054] The burner-start-up is terminated if during the respective burner-start-up the pressure difference is below the threshold.

[0055] The terminated burner-start-up is not considered as a failed burner-start-up.

[0056] During each burner-start-up of the gas burner appliance 10, 10', 10" it is monitored if the burner-start-up results into a combustion of the gas/air mixture within a defined start-up time interval. If the burner-start-up did not result into a combustion within the defined start-up time interval and if the pressure difference determined during the start-up time interval is below the threshold, then not considering the burner-start-up is as a failed burner-start-up. If the burner-start-up did not result into a combustion within a defined start-up time interval and if the pressure difference determined during the start-up time interval is above the threshold, then considering the burner-start-up as a failed burner-start-up.

[0057] If the first gas safety valve 19a and a second gas safety valve 19b can be opened and closed independently from each other, then the following streps may be executed: Measuring also before the burner-start-up of the gas burner appliance 10 the second absolute pressure by the absolute pressure sensor 21 when the first gas safety valve 19a is opened and the second gas safety valve 19b is closed. For this measurement the fan 14 is not running. Further, determining the pressure difference between the first absolute pressure and the second absolute pressure. Still further, comparing the pressure difference with the threshold. The burner-start-up is prevented when the pressure difference is below the threshold. The burner-start-up is allowed when the pressure difference is above the threshold. This is of advantage to avoid that a gas/air mixture which is not ignitable enters into the combustion chamber 11 in connection with a

burner-start-up.

[0058] The method may comprise the following additional steps: If a burner-start-up has not been considered as a failed burner-start-up, then preventing a new burner-start-up of the gas burner appliance 10 for a defined recheck time interval. Executing again the above steps providing the electrical or electronic pressure-switch functionality after the defined recheck time interval is expired. So, if a burner-start-up did not result into an ignition but has not been considered as a failed burner-start-up, then a new burner-start-up is executed for security reasons only after the defined recheck time interval.

[0059] As mentioned above, during each burner-start-up of the gas burner appliance 10, 10', 10" it is monitored if the burner-start-up results into a combustion of the gas/air mixture within a defined start-up time interval. The start-up time interval is also called safety time interval. This start-up time interval is the maximum time interval for the burner-start-up in which the safety gas valves 19a, 19b are opened without detection of a flame 12. Alternatively, a burner-start-up may be terminated before the end of the defined start-up time interval if it is detected during this start-up time interval that the pressure difference is below the threshold, meaning that the gas inlet pressure is insufficient. Such a terminated burner-start-up will also not be considered as a failed burner-start-up.

[0060] The method may comprise the following additional steps: If the burner-start-up results into a combustion within the defined start-up time interval, then measuring during a regular combustion mode the second pressure continuously or at a defined sampling rate. Determining during the regular combustion mode the pressure difference between the first absolute pressure and the second absolute pressure continuously or at the defined sampling rate during combustion. Comparing during the regular combustion mode the pressure difference with the threshold continuously or at the defined sampling rate. If during regular combustion the pressure difference drops below the threshold during combustion, then terminating the combustion. This increases security during a regular combustion mode.

[0061] The inventions also related to the controller 26 of a gas burner appliance 10, 10', 10" for operating the gas burner appliance 10, 10', 10", wherein the controller 26 is configured to execute the above-described method.

[0062] The controller 26 is configured provide an electrical or electronic pressure-switch functionality by executing the following steps:

Before each burner-start-up of the gas burner appliance 10, 10', 10", measure a first absolute pressure by the absolute pressure sensor 21 when the first gas safety valve 19a is closed, said first absolute pressure being representative of an ambient pressure.

[0063] During each burner-start-up of the gas burner appliance 10, 10', 10", measure a second absolute pressure by the absolute pressure sensor 21 when at least the first gas safety valve 19a is opened, said second absolute pressure being representative of a gas pressure, further determine a pressure difference between the first absolute pressure and the second absolute pressure, still further compare the pressure difference with a threshold.

[0064] Allow or prevent a lockout of gas burner appliance 10, 10', 10" is on basis of the comparison of the pressure difference with the threshold.

List of reference signs

[0065]

10	gas burner appliance
10'	gas burner appliance
10"	gas burner appliance
11	combustion chamber
12	flame
13	flame ionization sensor
14	fan
15	air duct
16	gas duct
17	gas armature
18	gas flow modulator
19	safety gas valve unit
19a	safety gas valve
19b	safety gas valve
20	sieve
21	absolute pressure sensor
21a	measuring point
22	coil
23	actuator
24	coil
25	mixer
26	controller
27	electric or electronic sensor
28	gas flow regulator
28a	pneumatic controller
28b	gas regulation valve
29	exhaust pipe

Claims

1. Method for operating a gas burner appliance (10, 10', 10"), the gas burner appliance comprising:

   a combustion chamber (11) being configured to combust a defined gas/air mixture,
   a mixing device (23) being configured to provide said gas/air mixture by mixing an air flow provided by an air duct (15) with a gas flow provided by a gas duct (16),
   a fan (14) being configured provide the air flow or the flow of the gas/air mixture,
   a gas safety valve unit (19) assigned to the gas duct (16) being configured to open or close the gas duct (16),
   the gas safety valve unit (19) having a first gas safety valve (19a) and a second gas safety valve

(19b) positioned downstream of the first gas safety valve (19a),
a gas flow modulator (18) or gas flow regulator (28) assigned to the gas duct (16) being configured to keep the mixing ratio of gas and air at a defined value,
an electrical or electronic absolute pressure sensor (21) assigned to the gas duct (16) positioned downstream of the first gas safety valve (19a),
wherein the gas burner appliance (10) goes into lockout state if a defined number of burner-start-ups of the gas burner appliance failed, namely did not result into a combustion,
wherein the gas burner appliance (10, 10', 10") is operated by executing the following steps to provide an electrical or electronic pressure-switch functionality:

before each burner-start-up of the gas burner appliance, measuring a first absolute pressure by the absolute pressure sensor (21) when the first gas safety valve (19a) is closed, said first absolute pressure being representative of an ambient pressure,
during each burner-start-up of the gas burner appliance:

measuring a second absolute pressure by the absolute pressure sensor (21) when the first gas safety valve (19a) is opened, said second absolute pressure being representative of a gas pressure,
determining a pressure difference between the first absolute pressure and the second absolute pressure,
comparing the pressure difference with a threshold,

wherein a lockout of gas burner appliance is allowed or prevented on basis of the comparison of the pressure difference with the threshold.

2. Method of claim 1, **characterized in that**

during each burner-start-up of the gas burner appliance

the second pressure is measured continuously or at a defined sampling rate,
the pressure difference between the first absolute pressure and the second absolute pressure is determined continuously or at the defined sampling rate,
the pressure difference is compared with the threshold continuously or at the defined sampling rate,

the burner-start-up is terminated if during the respective burner-start-up the pressure difference is below the threshold,
such a terminated burner-start-up is not considered as a failed burner-start-up.

3. Method of claim 1 or 2, **characterized in that**
during each burner-start-up of the gas burner appliance it is monitored if the burner-start-up results into a combustion of the gas/air mixture within a defined start-up time interval, wherein

if the burner-start-up did not result into a combustion within the defined start-up time interval and if the pressure difference determined during the start-up time interval is below the threshold, then not considering the burner-start-up is as a failed burner-start-up,
if the burner-start-up did not result into a combustion within the defined start-up time interval and if the pressure difference determined during the start-up time interval is above the threshold, then considering the burner-start-up as a failed burner-start-up.

4. Method of one of claims 1 to 3, **characterized in that**
if the electrical or electronic absolute pressure sensor (21) is positioned downstream of the first gas safety valve (19a) and upstream of the second gas safety valve (19b), then

measuring the first absolute pressure when the first gas safety valve (19a) is closed, when the second gas safety valve (19b) is opened, and when the fan (14) is not running,
measuring the second absolute pressure during the burner-start-up when the first gas safety valve (19a) and the second gas safety valve (19b) are both opened and when the fan (14) is running.

5. Method of one of claims 1 to 3, **characterized in that**
if the electrical or electronic absolute pressure sensor (21) is positioned downstream of the second gas safety valve (19b), then

measuring the first absolute pressure when the first gas safety valve (19a) is closed, when second gas safety valve (19b) is opened or closed, and when the fan (14) is not running,
measuring the second absolute pressure during the burner-start-up when the first gas safety valve (19a) and the second gas safety valve (19b) are both opened and when the fan is running.

6. Method of one of claims 1 to 5, **characterized in that** if the first gas safety valve (19a) and the second gas safety valve (19b) can be opened and closed independently from each other, then

measuring also before the burner-start-up of the gas burner appliance the second absolute pressure by the absolute pressure sensor (21) when the first gas safety valve (19a) is opened, when the second gas safety valve (19b) is closed and when the fan (14) is not running,
determining the pressure difference between the first absolute pressure and the second absolute pressure,
comparing the pressure difference with the threshold,
wherein the burner-start-up is prevented when the pressure difference is below the threshold,
wherein the burner-start-up is allowed when the pressure difference is above the threshold.

7. Method of one of claims 1 to 6, **characterized in that**

if a burner-start-up has not been considered as a failed burner-start-up, then preventing a new burner-start-up of the gas burner appliance for a defined recheck time interval,
executing again the above steps providing the electrical or electronic pressure-switch functionality after the defined recheck time interval is expired.

8. Method of one of claims 1 to 7, **characterized in that**

if the burner-start-up results into a combustion, then

measuring during a regular combustion mode the second pressure continuously or at a defined sampling rate,
determining during the regular combustion mode the pressure difference between the first absolute pressure and the second absolute pressure continuously or at the defined sampling rate during combustion, and
comparing during the regular combustion mode the pressure difference with the threshold continuously or at the defined sampling rate,

if during combustion the pressure difference drops below the threshold, then terminating the combustion.

9. Controller (26) of a gas burner appliance (10, 10', 10") for operating the gas burner appliance (10, 10', 10"),
the controller (26) is configured to provide an electrical or electronic pressure-switch functionality by executing the following steps:

before each burner-start-up of the gas burner appliance (10, 10', 10"), measure a first absolute pressure by an absolute pressure sensor (21) assigned to a gas duct when a first gas safety valve (19a) assigned to the gas duct is closed, said first absolute pressure being representative of an ambient pressure,
during each burner-start-up of the gas burner appliance (10, 10', 10"):

measure a second absolute pressure by the absolute pressure sensor (21) when at least the first gas safety valve (19a) is opened, said second absolute pressure being representative of a gas pressure,
determine a pressure difference between the first absolute pressure and the second absolute pressure,
compare the pressure difference with a threshold,

allow or prevent a lockout of gas burner appliance (10, 10', 10") on basis of the comparison of the pressure difference with the threshold.

10. Controller of claim 9, **characterized in that** the controller (26) is configured to operate the gas burner appliance according to the method of one of claims 1 to 8.

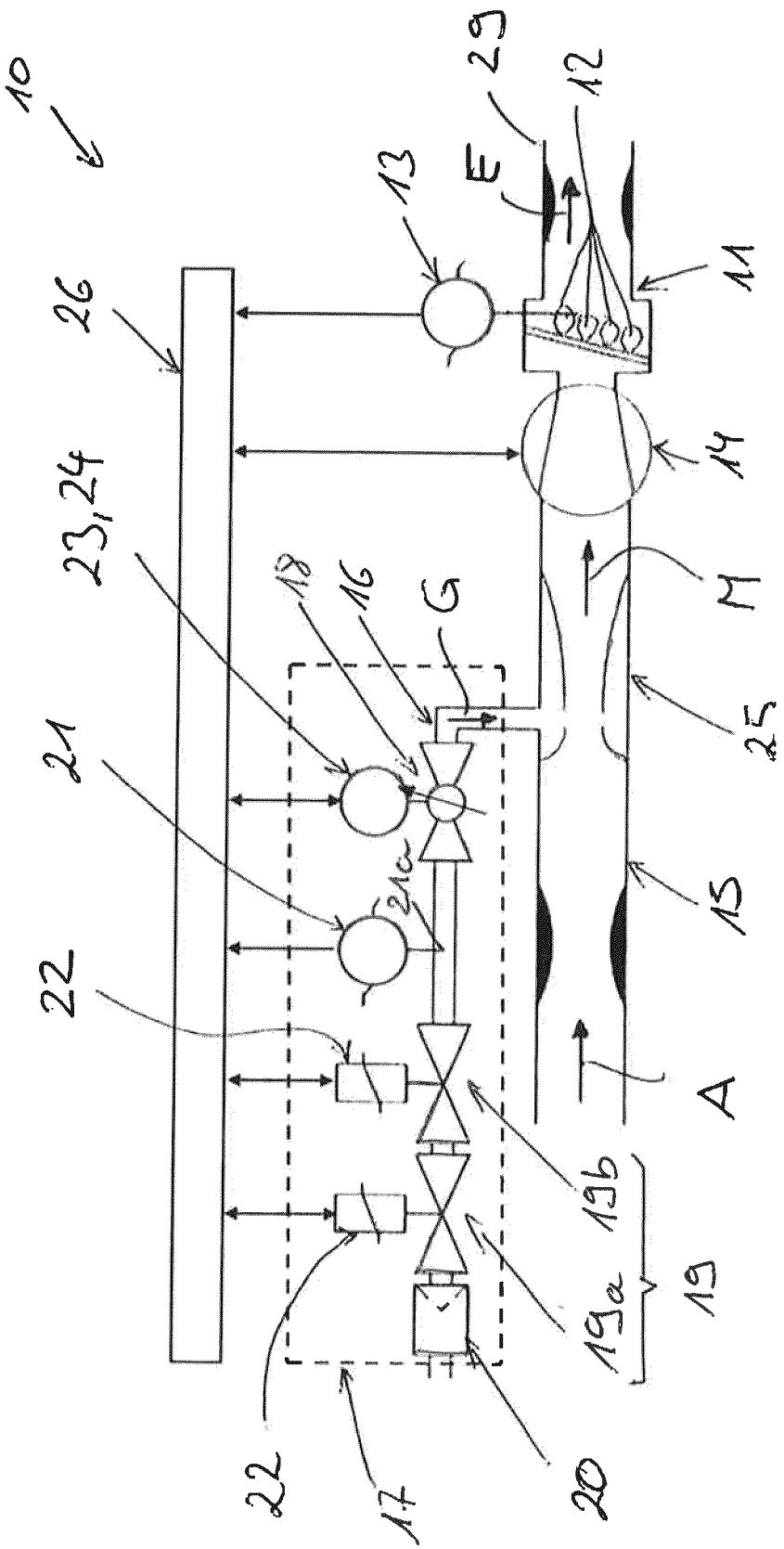
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Fig. 1

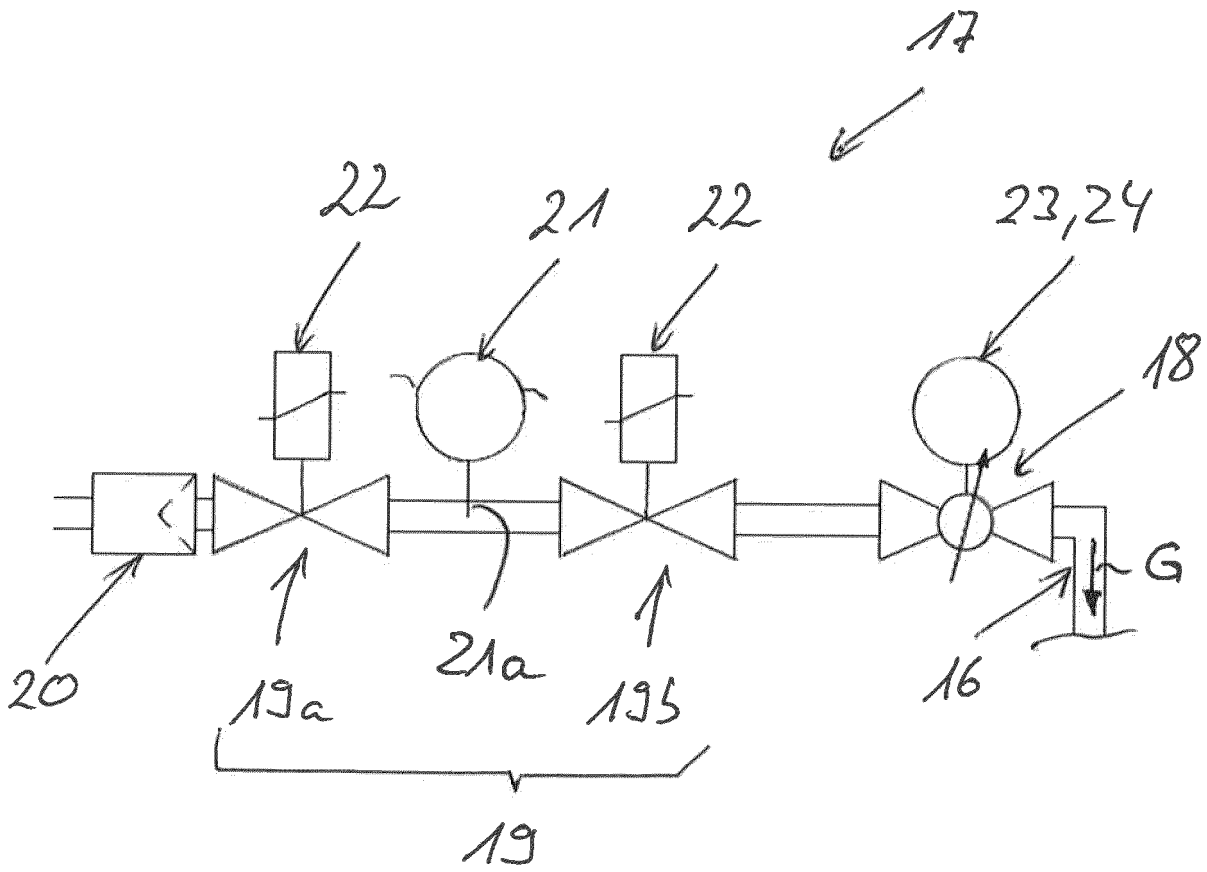

Fig. 2

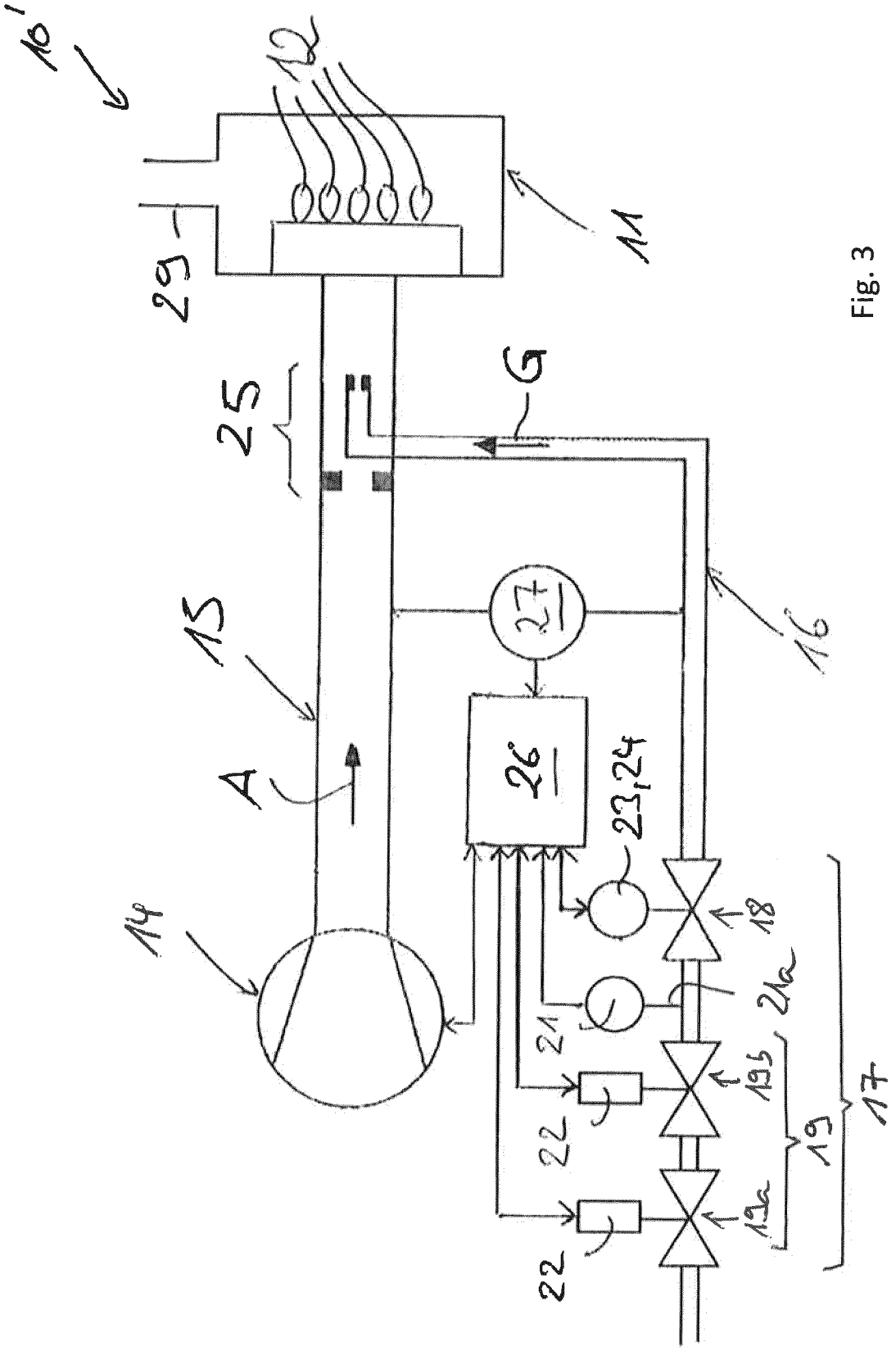

Fig. 3

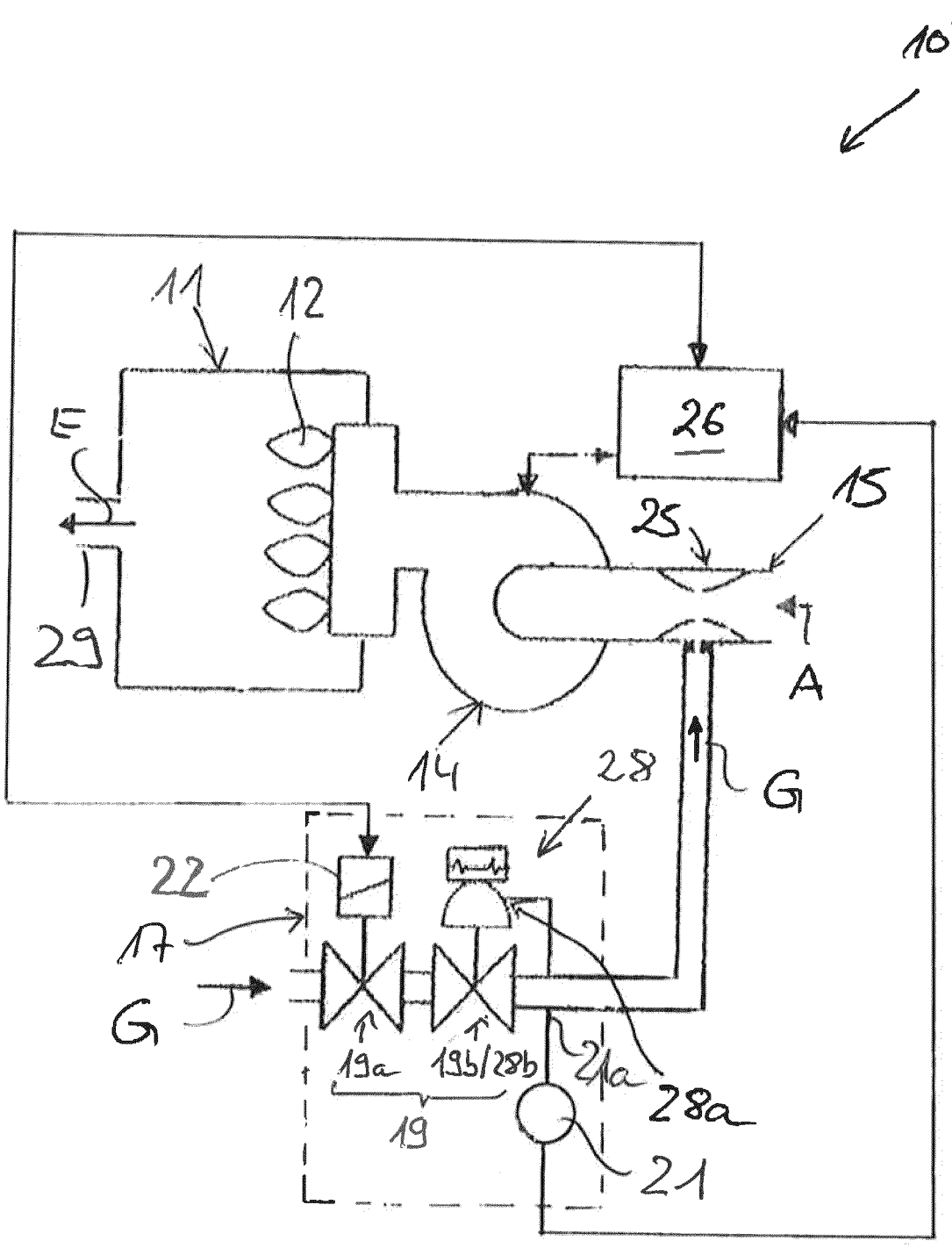

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 5472

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F23N
F23D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 November 2021	Vogl, Paul

CATEGORY OF CITED DOCUMENTS

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