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(54) Method for operating a premix gas burner

(57) Method for operating a premix 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). 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). 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) or an exhaust duct (27). The gas flow provided by the gas duct (16) depends on a position of at least one gas valve (18, 19) assigned to the gas duct (16). Flames (12) resulting from the combustion of the defined gas/air mixture within the burner chamber (11) are monitored by an ionization sensor (13). Exhaust gas resulting from the combustion of the defined gas/air mixture within the burner chamber (11) leaves the burner chamber (11) though the exhaust duct (27) of the burner chamber (11) to which a temperature sensor (25) is assigned. During burner-on phases a pre-purge-check and an ignition-check and a flue-check and a running-check and a gas-pressure-check and a post-purge-check are executable by monitoring and analysing an ionization signal of the ionization sensor (13) and/or a signal being indicative of a power consumption of the fan (14) and/or a fan speed signal of the fan (14) and/or an exhaust gas temperature signal of the temperature sensor (25) in order to detect a potential blockage within the gas burner (10), wherein the combustion in the gas burner (10) is stopped or will be brought to a level where the combustion is hygienic if a potential blockage within the gas burner (10) is detected. (Figure 1)

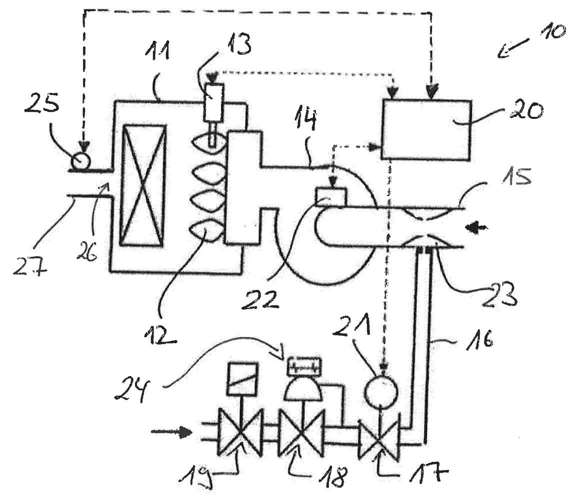

Fig 1

EP 3 043 115 A1

Description

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

[0002] EP 2 667 097 A1 discloses a method for operating a premix gas burner, especially a pneumatic premix gas burner. During burner-on phases a defined gas/air mixture having a defined mixing ratio of gas and air is provided to a burner chamber of the gas burner for combusting the defined gas/air mixture within the burner chamber. The defined 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 air flow provided by the air duct depends on a fan speed of a fan assigned to the air duct or the burner chamber. The gas flow provided the gas duct depends on a position of at least one gas valve assigned to the gas duct. Flames resulting from the combustion of the defined gas/air mixture within the burner chamber are monitored by an ionization sensor. Exhaust gas resulting from the combustion of the defined gas/air mixture within the burner chamber leaves the burner chamber though an exhaust outlet and exhaust duct of the burner chamber.

[0003] EP 2 447 609 A1 discloses another method for operating a fan assisted atmospheric gas burner, not a premix gas burner. According to this prior art the air flow is provided by a fan assigned to the air duct or to the exhaust duct. A temperature sensor is assigned to the exhaust duct for measuring an exhaust gas temperature. A signal provided by the temperature sensor preferably in combination with a signal provided by an ionization sensor is usedto determine the opening status and/or closing status of the exhaust duct and/or of the air duct.

[0004] A gas burner has to be fail-safe. It has to be ensured that no leakage of exhaust gas leaks into the ambient of the gas burner, especially into a room where the gas burner is installed. However, manufacturers of gas burners are more and more oriented to cheap mechanical solutions which do not provide good sealing properties. So, exhaust gas leakage may occur. This has to be avoided. Against this background, a novel method for operating a gas burner is provided.

[0005] The method for operating a premix gas burner according to the present application is defined in the claim 1. During burner-on phases a pre-purge-check and an ignition-check and a flue-check and a running-check and a gas-pressure-check and a post-purge-check are executable by monitoring and analysing an ionization signal of the ionization sensor and/or a signal being indicative of a power consumption of the fan and/or a fan speed signal of the fan and/or an exhaust gas temperature signal of the temperature sensor in order to detect a potential blockage within the gas burner, wherein the combustion in the gas burner is stopped or will be brought to a level where the combustion is hygienic if a potential blockage within the gas burner is detected. The invention allows to detect a potential blockage within the gas burner which may cause an exhaust gas leakage. If such a potential blockage is detected the combustion within the gas burner will be stopped or will be brought to a level where the combustion is hygienic. A hygienic combustion means that the CO (carbon monoxide) concentration is below a defined threshold. Exhaust gas leakage can be avoided.

[0006] According to a preferred embodiment, the pre-purge-check is only executed during an actual burner-on phase after a burner start has been requested by an actual heat demand if during a previous burner-on phase a potential blockage was detected. The ignition-check is executed during an actual burner-on phase after a burner start has been requested by an actual heat demand, after the optional execution of the pre-purge-check, after the at least one gas valve assigned to the gas duct has been opened and after flames are established by the combustion of the gas/air mixture. After the ignition-check has been executed the flue-check and the running-check and the gas-pressure-check and the post-purge-check are executable if no potential blockage was detected during the ignition-check. The running-check is only executed if no potential blockage was detected during the flue-check and if the fan speed is almost constant. The post-purge-check is only executed if a potential blockage has been detected during the running-check or during the flue-check. With such a method a potential blockage within the gas burner which may cause an exhaust gas leakage can be securely detected.

[0007] An almost constant fan speed means that the variation of the fan speed is smaller than a defined threshold.

[0008] Preferably, for the execution of the pre-purge-check the signal being indicative of a power consumption of the fan which results from maintaining the fan speed of the fan almost constant at a defined pre-purge fan speed level during a defined pre-purge time interval is monitored and analysed, wherein a potential blockage is detected if the signal being indicative of a power consumption of the fan of the fan differs from a defined nominal value for more than a defined time interval. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage during the pre-purge status of the gas burner.

[0009] Preferably, for the execution of the ignition-check the ionization signal provided by the ionization sensor which results from maintaining the burner load almost constant at a defined ignition load for a defined ignition time interval is monitored and analysed, wherein a potential blockage is detected if the ionization signal is smaller than a defined nominal value. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage during the ignition status of the gas burner.

[0010] An almost constant burner load means that the variation of the burner load is smaller than a defined threshold

[0011] Preferably, for the execution of the gas-pressure-check the ionization signal provided by the ionization sensor is monitored and analysed, wherein a potential blockage is detected if the ionization signal is smaller than a defined nominal value. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage during the running status of the gas burner.

[0012] Preferably, for the execution of the flue-check the combustion is kept turned on for a defined time interval so that at least the ionization sensor reaches a thermal equilibrium, wherein the exhaust gas temperature signal provided by the temperature sensor is monitored and analysed during said time interval, and wherein a potential blockage is detected if the exhaust gas temperature is smaller than a defined nominal value and/or id the exhaust gas temperature has a slope being smaller than a defined nominal value. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage also during the running status of the gas burner.

[0013] Preferably, for the execution of the running-check the ionization signal provided by the ionization sensor and the signal being indicative of a power consumption of the fan are monitored and analysed, wherein a potential blockage is detected if the variation of the flame ionization signal is larger than a defined nominal value or if the variation of the signal being indicative of a power consumption of the fan is larger than a defined nominal value. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage also during the running status of the gas burner.

[0014] Preferably, for the execution of the post-purge-check the signal being indicative of a power consumption of the fan which results from maintaining the fan speed of the fan almost constant at a defined post-purge fan speed level during a defined post-purge time interval is monitored and analysed, wherein a potential blockage is detected if the signal being indicative of a power consumption of the fan of the fan differs from a defined nominal value for more than a defined time interval. This allows a secure detection of a potential blockage which may cause an exhaust gas leakage during the post-purge status of the gas burner.

[0015] 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 block diagram illustrating the present invention;
Figure 3	shows signals further illustrating the present invention;
Figure 4	shows further signals further illustrating the present invention;
Figure 5	shows further signals further illustrating the present invention; and
Figure 6	shows further signals further illustrating the present invention.

[0016] Figure 1 shows a schematic view of a pneumatic premix gas burner 10.

[0017] The gas burner 10 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.

[0018] 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 preferably assigned to the burner chamber 11 or air duct 14 sucks in air flowing through an air duct 15 and gas flowing though 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. Further on a throttle 17 with an actuator 21 is assigned to the gas duct 16 allowing the calibration to different gas qualities.

[0019] 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.

[0020] 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. 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.

[0021] 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 duct 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.

[0022] 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. Alternatively, it is possible to determine the pressure difference between the gas pressure of the gas flow in the gas duct 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 and the gas burner would be an controller premix gas burner.

[0023] In any case, the mixing ratio of the defined gas/air mixture is controlled is 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. 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.

[0024] Exhaust gas resulting from the combustion of the defined gas/air mixture within the burner chamber 11 leaves the burner chamber 11 though an exhaust outlet 26 and exhaust duct 27. A temperature sensor 25 is assigned to the exhaust duct 27 for measuring an exhaust gas temperature.

[0025] The gas burner 10 has to be fail-safe. It has to be ensured that no leakage of exhaust gas leaks into the ambient of the gas burner 10, especially into a room where the gas burner 10 is installed. The present invention provides a reliable and secure method for operating a gas burner by which such a leakage can be avoided and by which a hygienic combustion can be provided.

[0026] According to the present invention, during burner-on phases of the gas burner 10 a pre-purge-check and an ignition-check and a flue-check and a running-check and a gas-pressure-check and a post-purge-check are executable by monitoring and analysing an ionization signal of the ionization sensor 13 and a signal being indicative of a power consumption of the fan 14 and a fan speed signal of the fan 14 and an exhaust gas temperature signal of the temperature sensor 25 in order to detect a potential blockage within the gas burner 10, wherein the combustion in the gas burner 10 is stopped or will be brought to a level where the combustion is hygienic if a potential blockage within the gas burner 10 is detected. A hygienic combustion means that the CO (carbon monoxide) concentration is below a defined threshold of e.g. 2000 ppm. The combustion can be brought to a hygienic level be decreasing fan speed and thereby burner load.

[0027] The signal being indicative of a power consumption of the fan 14 is hereinafter called fan power consumption signal of the fan 14.

[0028] The method will be described below in more detail with reference to Figure 2.

[0029] Block 100 in Figure 2 illustrates that an actual heat demand is present and that the burner should be transferred from a burner-off phase into an actual burner-on phase. Subsequently it will be checked in block 101 if a potential blockage was detected during a previous burner-on phase. This is done by checking if blockage flag is set active.

[0030] If it is determined in bock 101 that no potential blockage was detected during a previous burner-on phase, the execution of the method according to the invention will jump to block 132. Then a regular pre-purge phase for the gas burner which is known to the person skilled in the art will be executed by block 132. If it is determined in bock 101 that a potential blockage was detected during a previous burner-on phase, the execution of the method according to the invention will jump to block 102. Blocks 102, 103 represent a pre-purge phase for the gas burner including a pre-purge-check. So, the pre-purge-check is only executed during an actual burner-on phase after a burner start has been requested by an actual heat demand (block 100) if a potential blockage was detected during a previous burner-on phase by block 101.

[0031] During the execution of the pre-purge-check the fan power consumption signal of the fan 14 which results from maintaining the fan speed of the fan 14 constant at a defined pre-purge fan speed level during a defined pre-purge time interval is monitored and analysed. A potential blockage of the gas burner 10 is detected in block 103 if the fan power consumption signal of the fan 14 differs, preferably more than a defined threshold, from a defined nominal value for more than a defined time interval. If a potential blockage of the gas burner 10 is detected in block 103 in response to the pre-purge-check, the execution of the method according to the invention will jump to block 105. In block 105 the combustion in the gas burner 10 will be stopped. Then a lock-out error will be set in block 106.After a defined time interval a reset will be executed in block 107 allowing a subsequent new burner start when a new heat demand is present.

[0032] If no potential blockage of the gas burner 10 is detected in block 103 in response to the pre-purge-check, the execution of the method according to the invention will jump to block 104. In block 104 the blockage flag is set inactive.

[0033] An explained above, during the execution of the pre-purge-check the fan power consumption signal of the fan 14 is monitored and analysed. A potential blockage is detected by the pre-purge-check if the fan power consumption signal of the fan 14 differs from the defined nominal value for more than the defined time interval when the fan speed of the fan 14 is kept constant at the defined pre-purge fan speed level for the defined pre-purge time interval.

[0034] Figure 3 illustrates further details of the pre-purge-check. In Figure 3 a fan speed signal 200 corresponding to the speed "n" of the fan 14 during the pre-purge-check, a fan power consumption signal 201 being indicative of the power consumption "P" of the fan 14 during the pre-purge-check and a filter signal 202 are shown over the time "t". The fan power consumption signal 201 is preferably a PWM (pulse wide modulation) signal. The PWM signal 201 is indicative of the power that is needed by the fan 14 to maintain the fan speed at the defined nominal value which is also called pre-purge fan speed level. In the embodiment shown in Figure 3 said nominal value or pre-purge fan speed level is at e. g. 6000 rpm. The pre-purge phase including the pre-purge-check begins at the point of time "t0". The fan speed "n" is increased by a controller to the defined nominal value or pre-purge fan speed level. Said controller can e.g. make use a PID control strategy. As the fan 14 is driven by the controller, the fan speed will be kept constant, even if a blockage within the gas burner 10 like a blockage of the exhaust gas flow or a blockage of the air flow is present. However, the power consumption will be effected by such a blockage. The fan PWM signal 201 will then have a lower duty cycle "DC" to maintain the fan speed at the respective nominal value. If the fan power consumption signal 201 is below a nominal value a potential blockage is detected. If the fan power consumption signal 201 is above the nominal value no potential blockage is detected. Said nominal value for the fan power consumption signal 201 is in the embodiment of Figure 3 at e.g. 130 DC%. A filter represented by the filter signal 202 makes the potential blockage detection by the pre-purge-check more accurate to avoid unwanted lock-out errors. As can be seen in Figure 3, the fan power consumption signal 201 needs to differ from the defined nominal value for more than a defined time interval which is defined by the filter signal. As a result, between "t0" and "t1" the fan power consumption signal 201 being below the nominal value for less than the defined time interval will not result into a detection of a potential blockage and into a lock-out error. However, between "t2" and "t3" the fan power consumption signal 201 is below the nominal value for more than the defined time interval so that a potential blockage is detected by the pre-purge-check.

[0035] As the fan power consumption "P" is dependent on an AC main power supply, a dedicated microprocessor AD channel is managed to monitor continuously the working voltage. Therefore, checks on the fan response use different nominal values and nominal values based on the AC main voltage.

[0036] Either after block 132 or after block 104 block 108 will be executed. Blocks 108, 109 represent the ignition-check that is executed during an actual burner-on phase after a burner start has been requested by an actual heat demand 100, after the optional execution of the pre-purge-check 102, after the at least one gas valve 18, 19 assigned to the gas duct 16 has been opened and after flames 22 are established by the combustion of the gas/air mixture.

[0037] During the execution of the ignition-check the ionization signal provided by the ionization sensor 13 which results from maintaining the burner load constant at a defined ignition load for a defined ignition time interval is monitored and analysed. In block 109 it is checked if the ionization signal is larger or smaller than a defined nominal value. A potential blockage is detected in block 109 if the ionization signal is, preferably more than a defined threshold, smaller than a defined nominal value.

[0038] The ignition-check is executed immediately after the at least one gas valve 18, 19 was opened. After the flame(s) 12 is (are) established, the gas burner 10 is maintained for a certain time period at the ignition load with a known nominal value for the flame ionization signal. Any decrease of ionization signal can be detected to advise that a potential blockage. This ignition-check is used to cover blockage event which may occur immediately after the pre-purge.

[0039] If a potential blockage is detected by the ignition-check, the execution of the method according to the invention will jump to block 110, whereby in block 110 the blockage flag is set active. Subsequently the execution of the method according to the invention will jump to blocks 105, 106 and 107 as explained above.

[0040] If no potential blockage is detected by the ignition-check, the execution of the method according to the invention will jump to blocks 111 and 113.

[0041] Blocks 111, 112 represent the gas-pressure-check. During the execution of the gas-pressure-check the ionization signal provided by the ionization sensor 13 is monitored and analysed. In block 112 it is checked if the ionization signal provided by the ionization sensor is smaller or larger than a defined nominal value. A potential blockage is detected in block 112 if the ionization signal is, preferably more than a defined threshold, smaller than the defined nominal value.

[0042] If a potential blockage is detected by the gas-pressure-check in block 112, the execution of the method according to the invention will jump to blocks 110, 105, 106 and 107 as explained above.

[0043] If no potential blockage is detected by the gas-pressure-check in block 112, the execution of the method according to the invention will jump back in a loop to block 111. During the operation of the gas burner, the gas-pressure-check will be executed continuous when the at least one gas valve 18, 19 is open.

[0044] Block 113 represents a defined time interval for which the combustion in the gas burner 10 is kept turned on after the execution of the ignition-check (blocks 108, 109) so that at least the ionization sensor 13 reaches a thermal equilibrium. When at least the ionization sensor 13 has reached the thermal equilibrium, the block 114 will be executed, wherein blocks 114, 115 represent the flue-check. For the execution of the flue-check the combustion is kept turned on for a defined time interval so that at least the ionization sensor 13 reaches a thermal equilibrium. The exhaust gas temperature signal provided by the temperature sensor 25 can be monitored and analysed during the flue-check by block 115. In block 115 it is checked if the exhaust gas temperature is smaller or larger than a defined nominal value and/or if the exhaust gas temperature has a slope being smaller or larger than a defined nominal value.

[0045] A potential blockage is detected by the flue-check in block 115 if the exhaust gas temperature is, preferably more than a defined threshold, smaller than a defined nominal value and/or if the exhaust gas temperature has a slope being, preferably more than a defined threshold, smaller than a defined nominal value. In this case the execution of the method according to the invention will jump to block 116.

[0046] In block 116 in the blockage flag is set active. Subsequently in block 117 the combustion in the gas burner 10 will be stopped. Afterwards block 118 will be executed, wherein blocks 118, 119 represent the post-purge check.

[0047] The post-purge check is similar to the pre-purge check. For the execution of the post-purge-check the fan power consumption signal of the fan 14 which results from maintaining the fan speed of the fan 14 constant at a defined post-purge fan speed level during a defined post-purge time interval is monitored and analysed, wherein a potential blockage is detected if the fan power consumption signal of the fan 14 differs, preferably more than a defined threshold, from a defined nominal value for more than a defined time interval.

[0048] The fan power consumption signal of the post-purge check of the fan 14 is compared in block 119 with the respective nominal value. If the fan power consumption signal of the fan 14 differs, preferably more than a defined threshold, from the respective nominal value for more than a defined time interval, a potential blockage is detected and the method execution jumps to the above blocks 106, 107.

[0049] If no potential blockage is detected by the pre-purge check, the method execution jumps to the block 120 in which the blockage flag is set inactive and subsequently to block 131, wherein block 131 represents a delay time interval after which a subsequent new burner start is allowed when a new heat demand is present.

[0050] No potential blockage is detected by the flue-check in block 115 if the exhaust gas temperature is larger than a defined nominal value and/or if the exhaust gas temperature has a slope being larger than a defined nominal value. In this case the execution of the method according to the invention will jump to block 121 and subsequently to block 122, wherein blocks 122, 123, 124, 125 represent the running-check.

[0051] The running-check is only executed if no potential blockage was detected during the flue-check in blocks 114, 115 and if the fan speed is constant meaning that no power modulation is requested. The observation of the constant fan speed or the observation that no power modulation is requested is represented by block 121.

[0052] If block 121 determines that fan speed is not constant meaning that power modulation is requested, the method execution jumps back in a loop back to bock 121. If block 121 determines that fan speed is constant meaning that no power modulation is requested, the method execution jumps to block 122 and subsequently executes the running-check.

[0053] Figures 4 and 5 illustrate the functionality of block 121. In Figures 4 and 5 the fan speed "n" is shown over the time "t". In block 121 the actual fan speed "n" at the point of time time "ti+1" is compared with the previous fan speed "n" at the point of time "ti", e.g. the fan speed of some seconds before, settable by a sampling timer. The power stability is reached when the difference between two successive fan speed samples is closed to zero, which means that the fan speed is stable and that no power modulation is requested. In this case the running check by blocks 122, 123, 124, 125 is enabled and it will last till a power modulation resulting into a change of the fan speed is requested.

[0054] In Figure 4 the running check by blocks 122, 123, 124 and 125 becomes enabled at the point of time "t5".

[0055] In Figure 5 the running check by blocks 122, 123, 124 and125 becomes disabled at the point of time "t3".

[0056] For the execution of the running-check the ionization signal provided by the ionization sensor 13 and the fan power consumption signal of the fan 14 are monitored and analysed. Block 123 corresponds to block 115 as explained above. In block 124 it is analysed if the variation of the flame ionization is smaller or larger than a defined nominal value. In block 125 it is analysed if the variation of the fan power consumption is smaller or larger than a defined nominal value.

[0057] A potential blockage is detected by block 123 if the exhaust gas temperature is, preferably more than a defined threshold, smaller than a defined nominal value and/or if the exhaust gas temperature has a slope being, preferably more than a defined threshold, smaller than a defined nominal value, wherein in this case the method execution jumps to block 116 and the subsequent blocks of the same. If no potential blockage is detected by block 123, the method execution jumps to block 124.

[0058] In block 124 it is analysed if the variation of the flame ionization signal is smaller or larger than a defined nominal value. If the variation of the flame ionization signal is smaller than the defined nominal value, no potential blockage is detected by the running-check in block 124 and the method execution jumps to block 125. If it is detected that the variation of the flame ionization signal is, preferably more than a defined threshold, larger than the defined nominal value, a potential blockage is detected by the running-check in block 124 and the method execution jumps to block 116 and the subsequent blocks of the same.

[0059] In block 125 it is analysed if the variation of the fan power consumption signal is smaller or larger than a defined nominal value. If the variation of the fan power consumption signal is smaller than the defined nominal value, no potential blockage is detected by the running-check in block 125 and the method execution jumps to block 126. If it is detected that the variation of the fan power consumption signal is, preferably more than a defined threshold, larger than the defined nominal value, a potential blockage is detected by the running-check in block 125 and the method execution jumps to block 116 and the subsequent blocks of the same.

[0060] Figure 6 illustrate the functionality of blocks 124, 125. In Figure 6 the fan power consumption signal 201 indicating the fan power consumption "P" and ionization signal 203 being an electrical ionization current "I" are shown over the time "t".

[0061] Before the point of time "t4" no potential blockage is detected. At the point of time "t4" a potential blockage is detected that because the variation ΔI of the flame ionization signal is larger than the defined nominal value.

[0062] Before the point of time "t4" the variation ΔI of the flame ionization signal 203 and the variation ΔP of the fan power consumption signal 201 are both smaller than the respective nominal value.

[0063] The nominal values used in blocks 124 and 125 are preferably determined during a gas burner characterization. With such a boiler characterization flame ionization and fan power consumption decreasing caused by a flow rate reduction are analysed. Once these measurement results are captured at different main supply voltages, e.g. 170V AC, 230V AC and 270V AC and at different power loads, e.g. 100%, 75%, 50%, 25% and 0%, the outcome is used as check reference to detect a potential blockage, e.g. a blockage of the exhaust pike, during running-check. If the ionization current drop or an power consumption drop is bigger than the respective nominal value determined during the boiler characterization, a potential blockage is detected. Blockage flag is set by block 116 and combustion is stopped by block 117.

[0064] If the execution of the running-check in blocks 123, 124 and 125 detects no potential blockage, block 126 is executed, whereby block 126 corresponds to block 121. In block 126 it is check if the fan speed is constant meaning that no power modulation is requested. If this is not the case, the method execution jumps back in a loop to bock 126. If block 126 determines that fan speed is constant meaning that no power modulation is requested, the method execution jumps to block 127.

[0065] Block 127 checks if the actual heat demand is still active. If the actual heat demand is active, the method execution jumps back to block 123. If the actual heat demand is inactive, the method execution jumps to block 128 and subsequently to blocks 129 and 130. In block 128 the combustion in the gas burner 10 is stopped. In block 129 a regular post-purge phase as known by the person skilled in the art is executed. Block 120 represents a stand-by modus of the gas burner.

[0066] With reference to Figures 2 to 6 the method has been described in such a way that the combustion in the gas burner 10 will be stopped if a potential blockage has been detected.

[0067] Alternatively it is also possible to bring the combustion to a hygienic level if a potential blockage has been detected. The combustion can be brought to a hygienic level be decreasing fan speed and thereby burner load. In this case the combustion in the gas burner 10 will not be stopped but modified.

[0068] It follows from the above description that at least the ignition-check and the gas-pressure-check or that at least the ignition-check and the flue-check become executed. Preferably, at least the ignition-check, the gas-pressure-check and flue-check become executed for each burner start or heat demand. The pre-purge-check is only executed during an actual burner-on phase after a burner start has been requested by an actual heat demand if during a previous burner-on phase a potential blockage was detected. The running-check is only executed if no potential blockage was detected during the flue-check and if the fan speed is almost constant. The post-purge-check is only executed if a potential blockage has been detected during the running-check or during the flue-check.

[0069] So, all of the above described checks are executable. If some of the same become in fact executed depends on the above described operation conditions and/or check results.

[0070] The inventions allow a stable and robust detection of a potential blockage within the gas burner 10 like a blockage of the exhaust gas flow in the exhaust duct 27 or a blockage of the air flow in the air duct 14.

[0071] The method is stable and robust for all potential operation conditions including different exhaust pipe configurations like different exhaust pipe lengths, different temperature conditions, different gas qualities and different gas burner loads. The inventions allow a stable and robust detection of blockages occurring immediate over a few seconds as well as stable and robust detection of a blockages occurring over a longer time period like hours or days.

List of reference signs

[0072]

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	temperature sensor
26	exhaust outlet
27	exhaust duct
100	block
101	block
102	block
103	block
104	block
105	block
106	block
107	block
108	block

109 block
110 block
111 block
112 block
113 block
114 block
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119 block
120 block
121 block
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123 block
124 block
125 block
126 block
127 block
128 block
129 block
130 block
131 block
132 block

200 fan speed signal
201 fan power consumption signal
202 filter signal
203 ionization signal

Claims

1. Method for operating a premix 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), wherein 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), wherein the gas flow provided by the gas duct (16) depends on a position of at least one gas valve (18, 19) assigned to the gas duct (16), wherein flames (12) resulting from the combustion of the defined gas/air mixture within the burner chamber (11) are monitored by an ionization sensor (13), and wherein exhaust gas resulting from the combustion of the defined gas/air mixture within the burner chamber (11) leaves the burner chamber (11) though the exhaust duct (27) of the burner chamber (11) to which a temperature sensor (25) is assigned, **characterized in that** during burner-on phases a pre-purge-check and an ignition-check and a flue-check and a running-check and a gas-pressure-check and a post-purge-check are executable by monitoring and analysing an ionization signal of the ionization sensor (13) and/or a signal being indicative of a power consumption of the fan (14) and/or a fan speed signal of the fan (14) and/or an exhaust gas temperature signal of the temperature sensor (25) in order to detect a potential blockage within the gas burner (10), wherein the combustion in the gas burner (10) is stopped or will be brought to a level where the combustion is hygienic if a potential blockage within the gas burner (10) is detected.

2. Method as claimed in claim 1, **characterized in that** the pre-purge-check is only executed during an actual burner-on phase after a burner start has been requested by an actual heat demand if during a previous burner-on phase a potential blockage was detected.

3. Method as claimed in claim 1 or 2, **characterized in that** for the execution of the pre-purge-check the signal being indicative of a power consumption of the fan (14)which results from maintaining the fan speed of the fan (14) almost constant at a defined pre-purge fan speed level during a defined pre-purge time interval is monitored and analysed, wherein a potential blockage is detected if the signal being indicative of a power consumption of the fan (14) differs from a defined nominal value for more than a defined time interval.

4. Method as claimed in one of claims 1 and 3, **characterized in that** the ignition-check is executed during an actual burner-on phase after a burner start has been requested by an actual heat demand, after the optional execution of the pre-purge-check, after the at least one gas valve (18, 19) assigned to the gas duct (16) has been opened and after flames (22) are established by the combustion of the gas/air mixture.

5. Method as claimed in one of claims 1 to 4, **characterized in that** for the execution of the ignition-check the ionization signal provided by the ionization sensor (13) which results from maintaining the burner load almost constant at a defined ignition load for a defined ignition time interval is monitored and analysed, wherein a potential blockage is detected if the ionization signal is smaller than a defined nominal value.

6. Method as claimed in one of claims 1 to 5, **characterized in that** after the ignition-check is executed the flue-check and the running-check and the gas-pressure-check and the post-purge-check are executable if no potential blockage was detected during the ignition-check.

7. Method as claimed in one of claims 1 to 6, **characterized in that** for the execution of the gas-pressure-check the ionization signal provided by the ionization sensor (13) is monitored and analysed, wherein a potential blockage is detected if the ionization signal is smaller than a defined nominal value.

8. Method as claimed in one of claims 1 to 7, **characterized in that** for the execution of the flue-check the combustion is kept turned on for a defined time interval so that at least the ionization sensor (13) reaches a thermal equilibrium, wherein the exhaust gas temperature signal provided by the temperature sensor (25) is monitored and analysed, and wherein a potential blockage is detected if the exhaust gas temperature is smaller than a defined nominal value and/or if the exhaust gas temperature has a slope being smaller than a defined nominal value.

9. Method as claimed in one of claims 1 to 8, **characterized in that** the running-check is only executed if no potential blockage was detected during the flue-check and if the fan speed is almost constant.

10. Method as claimed in one of claims 1 to 9, **characterized in that** for the execution of the running-check the ionization signal provided by the ionization sensor (13) and the signal being indicative of a power consumption of the fan (14) are monitored and analysed, wherein a potential blockage is detected if the variation of the flame ionization signal is larger than a defined nominal value or if the variation of the signal being indicative of a power consumption of the fan (14) is larger than a defined nominal value.

11. Method as claimed in one of claims 1 to 10, **characterized in that** the post-purge-check is only executed if a potential blockage has been detected during the running-check or during the flue-check.

12. Method as claimed in one of claims 1 to 11, **characterized in that** for the execution of the post-purge-check the signal being indicative of a power consumption of the fan (14) which results from maintaining the fan speed of the fan (14) almost constant at a defined post-purge fan speed level during a defined post-purge time interval is monitored and analysed, wherein a potential blockage is detected if the signal being indicative of a power consumption of the fan (14) differs from a defined nominal value for more than a defined time interval.

13. Method as claimed in one of claims 1 to 12, **characterized in that** a blockage flag is set active if a potential blockage has been detected during the ignition-check or the flue-check or the running-check or the gas-pressure-check.

14. Method as claimed in one of claims 1 to 13, **characterized in that** the method is performed when operating a pneumatic premix gas burner, wherein for a pneumatic premix gas burner 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 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 pneumatically by pneumatic sensor.

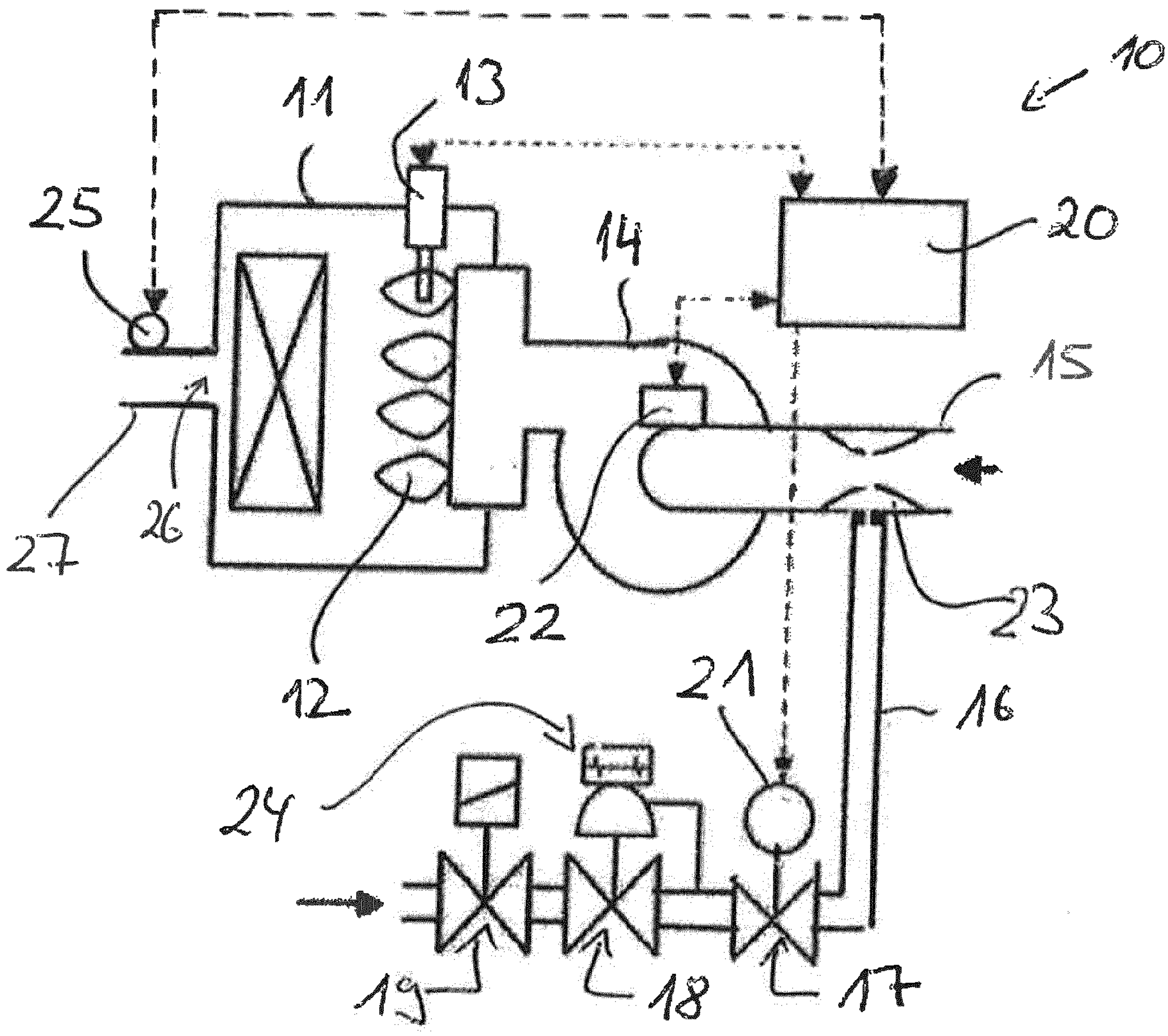

Fig.1

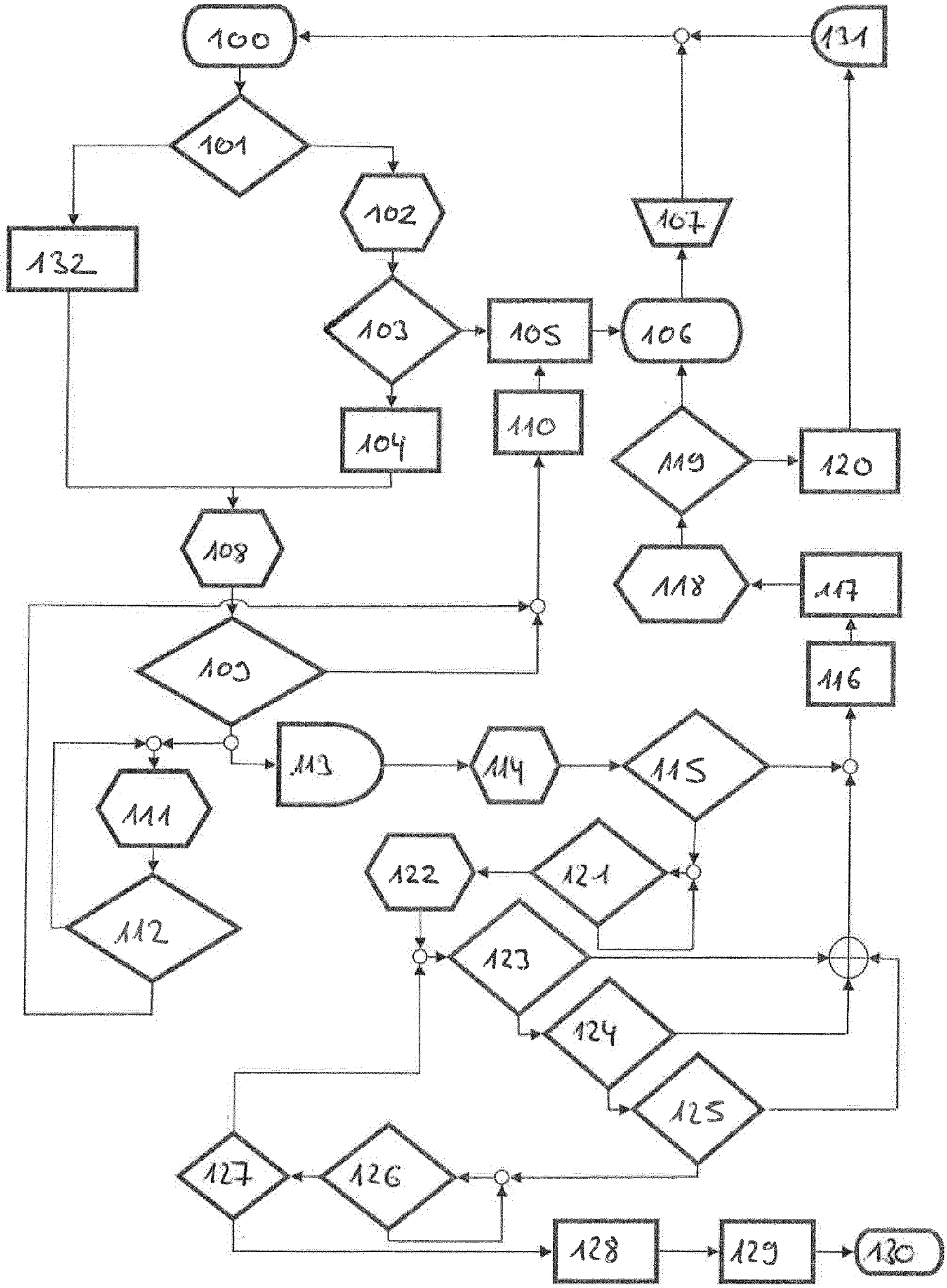
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Fig. 2

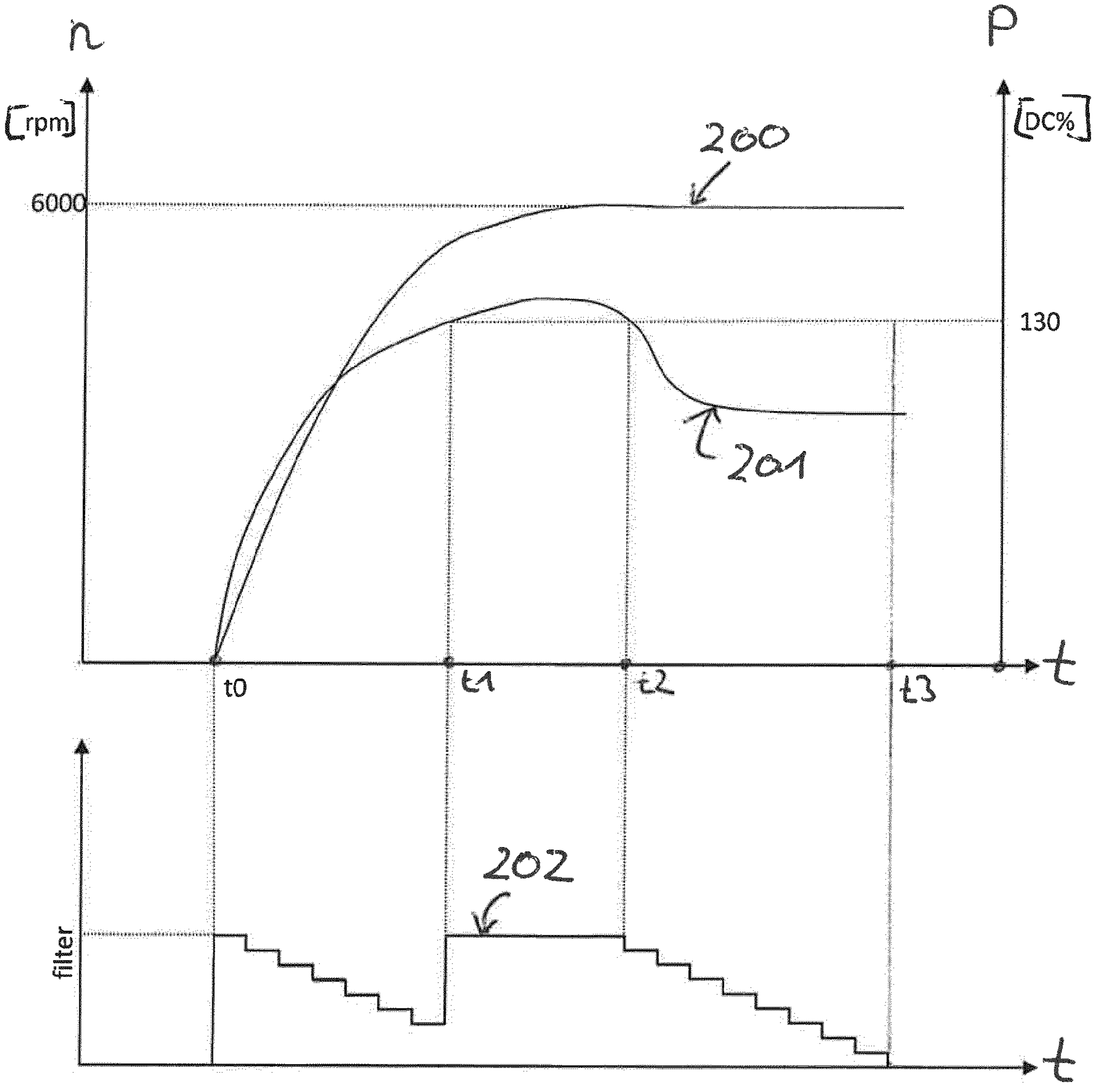

Fig 3

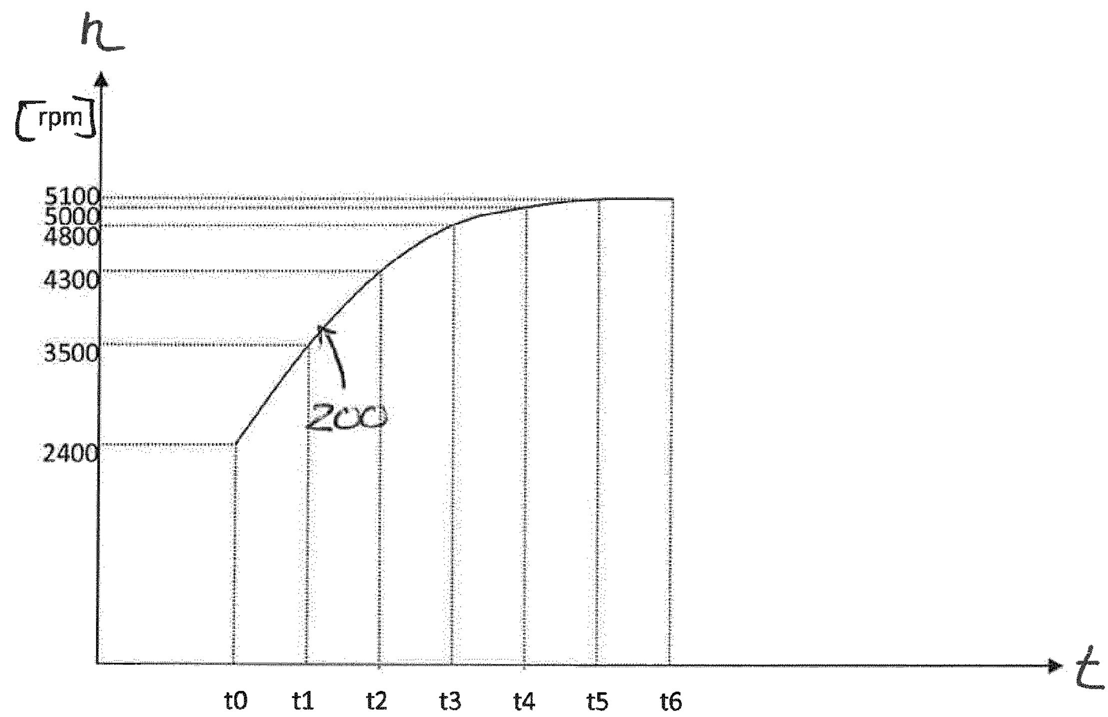
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Fig. 4

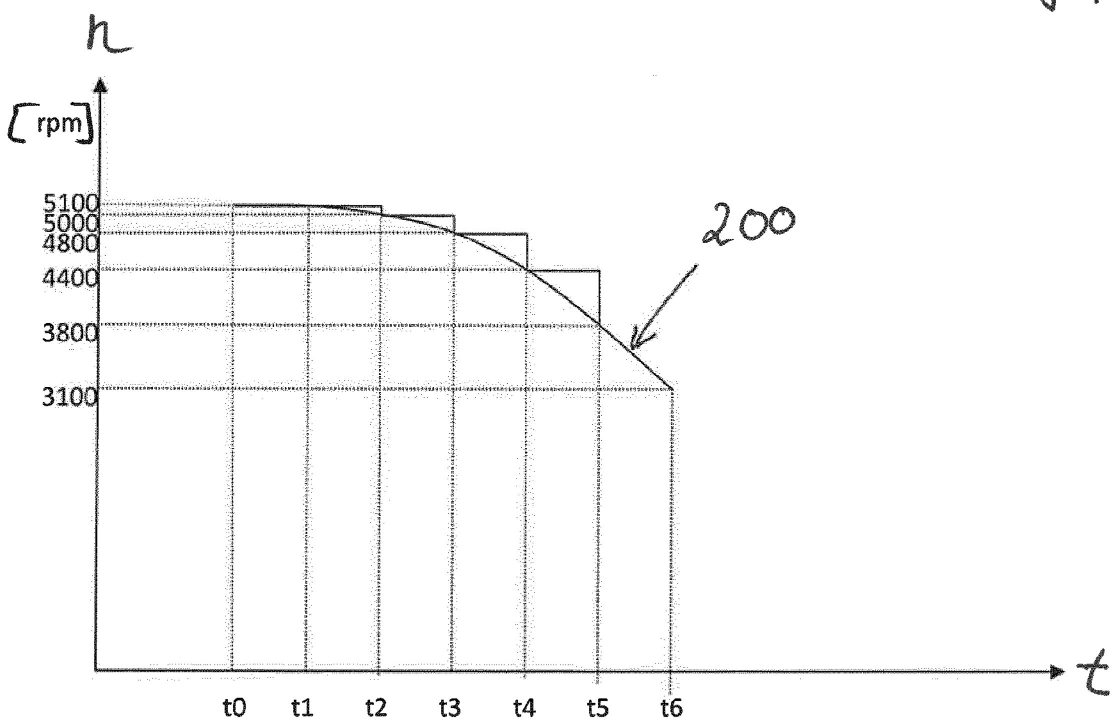
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Fig. 5

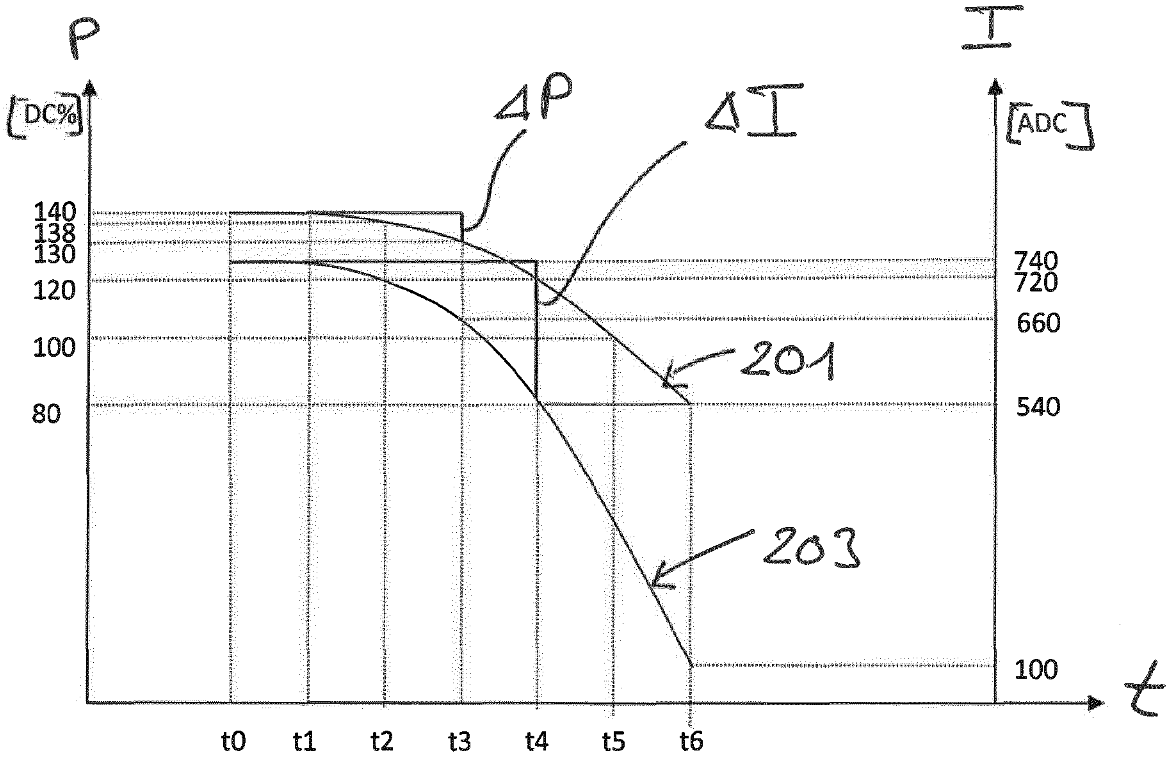
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Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 15 15 0797

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 Y	EP 2 631 541 A1 (HONEYWELL TECHNOLOGIES SARL [CH]) 28 August 2013 (2013-08-28) * column 2, paragraph 11 - paragraph 12 * * column 2, paragraph 16 - column 3, paragraph 23 * * column 4, paragraph 28 * * column 4, paragraph 33 - column 5, paragraph 35 * * claims 7-9 * * figure 1 * -----	1,3,5,6, 8-10, 12-14 2,4,7,11	INV. F23N5/00 F23N5/12 F23N5/24 F23D14/02
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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
Munich	18 June 2015	Gavriliu, Costin

CATEGORY OF CITED DOCUMENTS

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