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(54) **COMBUSTION MONITORING METHOD, DEVICE AND SYSTEM FOR NATURAL GAS BURNER**

(57) A natural gas burner control system and combustion monitoring method therefor. The natural gas burner control system comprises a combustion controller (10) and a gas analyzer (20). The combustion controller (10) is connected, in a wired or wireless connection manner, to the gas analyzer (20) and a control valve (50) that is located in a gas supply line (30), so as to obtain a signal sent from the gas analyzer (20) and send or obtain information to or from the control valve (50) in the gas supply line (30). The combustion monitoring method comprises: a gas analyzer (20) samples from a gas supply line (30) and analyzes the natural gas, so as to obtain measurement results of gas components comprised in the natural gas and corresponding contents; then, the gas analyzer (20) sends the measurement results to a combustion controller (10); after obtaining the measurement results, the combustion controller (10) inputs the measurement results, as input data, to a preset control model, and directly or indirectly determines control information corresponding to the measurement results according to the output result provided by the control model for the input data; then the combustion controller (10) increases or decreases the flow according to the corresponding control information. The device and method can pre-control a natural gas burner, thereby reducing the main combustion risks of the natural gas burner.

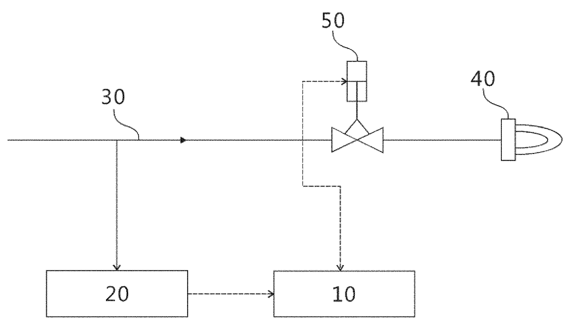

Fig.1

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Description

Technical field

[0001] The present invention relates to the field of burners, in particular to a combustion monitoring method, device and system for a natural gas burner.

Background art

[0002] As the hydrogen content in natural gas gradually increases, the natural gas becomes more and more dangerous. Hydrogen has a higher flammable range than pure methane, being flammable from 4% to 75% by volume, compared with 5% to 15% in the case of methane; the ignition energy is 15 times less than that of methane, and the combustion speed is 8 times more than that of methane. Thus, hydrogen explodes more easily than methane.

[0003] In the case of a high hydrogen content state, the main potential risks associated with combustion of a natural gas burner are as follows:

- burner overheating caused by flashback due to the high reactivity of hydrogen;
- instability of combustion caused by chemical change different from natural gas combustion, due to the faster movement of hydrogen;
- increased emission of nitrogen oxides due to the higher adiabatic combustion temperature of hydrogen.

[0004] In the prior art, generally, temperature monitoring is carried out installing a thermocouple at a flame outlet of a burner, and different protection operations are triggered on the basis of detected temperature signals. Such a method can only control the risk of overheating in natural gas combustion, and is unable to avoid the instability of combustion and the increased emission of nitrogen oxides.

Content of the invention

[0005] In view of the above, one problem solved by an embodiment of the present invention is the reduction of the main risks associated with combustion in a natural gas burner.

[0006] According to an embodiment of the present invention, a method for monitoring combustion of a natural gas burner is provided, wherein the natural gas burner is connected to a gas supply line, the gas supply line is connected to a natural gas combustion control system, and the natural gas combustion control system comprises a gas analyser and a combustion controller, the method comprising: the gas analyser taking a sample from the gas supply line, and analysing sampled natural gas to acquire a measurement result, wherein the measurement result comprises a gas component in the natural gas and a corresponding content; the gas analyser sending the measurement result to the combustion controller; the combustion controller inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content; the combustion controller adjusting a flow rate of natural gas in the gas supply line of the natural gas burner according to the control information.

[0007] Optionally, the natural gas combustion control system further comprises at least any one of a dynamic sensor, an emission sensor and a temperature sensor, with the dynamic sensor being arranged in a combustion chamber of the natural gas burner, the emission sensor being arranged downstream of the natural gas burner, and the temperature sensor being arranged on the natural gas burner, the combustion monitoring method further comprising: the combustion controller acquiring at least any one of a dynamic signal of the dynamic sensor, an emission signal of the emission sensor and a temperature signal of the temperature sensor, to serve as a feedback signal; wherein the step of the combustion controller determining control information comprises: the combustion controller inputting the measurement result and the feedback signal into a preset control model, to determine control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

[0008] Optionally, the control model performs real-time adjustment according to the feedback signal.

[0009] Optionally, control logic of the preset control model is also associated with an arrangement position of the sensor.

[0010] Optionally, one or more sensor of each type is arranged on one said natural gas burner, wherein the combustion monitoring method further comprises: the combustion controller triggering alarm information if at least any one of each type of arranged sensor fails.

[0011] Optionally, the combustion monitoring method further comprises: the combustion controller determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content; triggering an operation corresponding to the risk level.

[0012] Optionally, when the combustion controller also acquires the feedback signal, the step of determining risk level comprises: the combustion controller determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content, in combination with the feedback signal.

[0013] Optionally, the gas component and corresponding content are a hydrogen content.

[0014] According to an embodiment of the present invention, a method for monitoring combustion of a natural gas burner at a combustion controller end is provided, wherein the method comprises: acquiring a measurement result for natural gas in a gas supply line of the natural gas burner, wherein the measurement result comprises a gas component in the natural gas and a corresponding content; inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content; adjusting a flow rate of natural gas in the gas supply line of the natural gas burner according to the control information.

[0015] Optionally, the combustion monitoring method further comprises: acquiring at least any one of a dynamic signal of a dynamic sensor of the natural gas burner, an emission signal of an emission sensor and a temperature signal of a temperature sensor, to serve as a feedback signal; wherein the step of determining control information comprises: inputting the measurement result and the feedback signal into a preset control model, to acquire control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

[0016] Optionally, the combustion monitoring method further comprises: determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content; triggering an operation corresponding to the risk level.

[0017] According to an embodiment of the present invention, a natural gas combustion control system is provided, wherein the natural gas combustion control system comprises a gas analyser and a combustion controller; the gas analyser is connected to a gas supply line of a natural gas burner, and the gas analyser is used for taking a sample from the gas supply line; analysing sampled natural gas to acquire a measurement result, wherein the measurement result comprises a gas component in the natural gas and a corresponding content; and sending the measurement result to the combustion controller; the combustion controller comprises: an acquisition unit, for acquiring the measurement result sent by the gas analyser; a determining unit, for inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content; an adjustment unit, for adjusting a flow rate of natural gas in the gas supply line of the natural gas burner according to the control information.

[0018] Optionally, the natural gas combustion control system further comprises at least any one of a dynamic sensor, an emission sensor and a temperature sensor, with the dynamic sensor being arranged in a combustion chamber of the natural gas burner, the emission sensor being arranged downstream of the natural gas burner, and the temperature sensor being arranged on the natural gas burner, and the combustion controller further comprises: a feedback unit, for acquiring at least any one of a dynamic signal of the dynamic sensor, an emission signal of the emission sensor and a temperature signal of the temperature sensor, to serve as a feedback signal; wherein the determining unit is used for: inputting the measurement result and the feedback signal into a preset control model, to determine control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

[0019] Optionally, the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

[0020] Optionally, control logic of the preset control model is also associated with an arrangement position of the sensor.

[0021] Optionally, one or more sensor of each type is arranged on one said natural gas burner, wherein the combustion controller further comprises: an alarm unit, for triggering alarm information if at least any one of each type of arranged sensor fails.

[0022] Optionally, the combustion controller further comprises: a risk control unit, for determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content; a triggering unit, for triggering an operation corresponding to the risk level.

[0023] Optionally, when the combustion controller further comprises the feedback unit, the risk control unit is used for: determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content, in combination with the feedback signal.

[0024] Optionally, the gas component and corresponding content are a hydrogen content.

[0025] According to an embodiment of the present invention, a combustion controller for monitoring combustion of a natural gas burner is provided, wherein the combustion controller comprises: an acquisition unit, for acquiring a measurement result for natural gas in a gas supply line of the natural gas burner, wherein the measurement result comprises a gas component in the natural gas and a corresponding content; a determining unit, for inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content; an adjustment unit, for adjusting a flow rate of natural gas in the gas supply line of the natural gas burner according to the control information.

[0026] Optionally, the combustion controller further comprises: a feedback unit, for acquiring at least any one of a dynamic signal of a dynamic sensor of the natural gas burner, an emission signal of an emission sensor and a temperature signal of a temperature sensor, to serve as a feedback signal; wherein the determining unit is used for: inputting the measurement result and the feedback signal into a preset control model, to acquire control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

[0027] Optionally, the combustion controller further comprises: a risk control unit, for determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content; a triggering unit, for triggering an operation corresponding to the risk level.

[0028] In the embodiments of the present invention, combustion in the natural gas burner is controlled not merely according to temperature after combustion, etc.; the natural gas burned by the natural gas burner is subjected to gas analysis directly to acquire the measurement result, which is then inputted into the preset control model to determine control information corresponding to the measurement result, so as to adjust the flow rate of natural gas in the gas supply line of the natural gas burner according to the control information. Using this method, the combustion situation in the natural gas burner may be pre-judged precisely, thereby solving the problem of a lag in control, and reducing several of the principal risks associated with the natural gas burner. Furthermore, the embodiments of the present invention can also determine the control information or adjust the control information in combination with feedback signals from each type of sensor, further increasing the accuracy of control.

Description of the accompanying drawings

[0029] Other characteristics, features, advantages and benefits of the present invention will become more obvious through the following detailed description, which makes reference to the accompanying drawings.

Fig. 1 shows an architecture diagram of a natural gas combustion system using a natural gas combustion control system in one embodiment of the present invention.

Fig. 2 shows an architecture diagram of a natural gas combustion system using a natural gas combustion control system in another embodiment of the present invention.

Fig. 3 is a block diagram of a combustion controller according to an embodiment of the present invention.

Fig. 4 is a block diagram of a combustion controller according to another embodiment of the present invention.

Fig. 5 is a block diagram of a combustion controller according to another embodiment of the present invention.

Fig. 6 is a system flow chart of a combustion controller control method using a natural gas combustion control system according to an embodiment of the present invention.

Fig. 7 is a flow chart of a combustion controller control method according to an embodiment of the present invention.

Fig. 8 is a flow chart of a combustion controller control method according to another embodiment of the present invention.

Fig. 9 is a flow chart of a combustion controller control method according to another embodiment of the present invention.

Fig. 10 is a schematic diagram of a natural gas burner including two sensors according to an embodiment of the present invention.

Fig. 11 is a structural diagram of a combustion controller according to an embodiment of the present invention.

[0030] To aid understanding, identical drawing labels are used to represent identical elements common to the drawings where possible.

Particular embodiments

[0031] Preferred embodiments of the present disclosure are described in further detail below with reference to the accompanying drawings. Although the drawings show preferred embodiments of the present disclosure, it should be understood that the present disclosure may be realized in various forms, without being limited to the embodiments expounded here. On the contrary, these embodiments are provided in order to make the present disclosure more thorough and complete, and to enable the scope of the present disclosure to be transmitted in its entirety to those skilled in the art.

[0032] After reading the following explanation, those skilled in the art will recognize clearly that the teaching of the present invention may be easily used in combustion monitoring and control systems. The method, system and apparatus of the present invention are all suitable for premix burners or diffusion burners. Preferably, the present invention may be used in a gas turbine.

[0033] Fig. 1 shows an architecture diagram of a natural gas combustion system using a natural gas combustion control system in one embodiment of the present invention. The natural gas combustion control system comprises a combustion controller 10 and a gas analyser 20. The system architecture shown in fig. 1 is merely one example of the use of a natural gas combustion control system.

[0034] The combustion controller 10 is connected by wired or wireless connection to the gas analyser 20 and to a control valve 50 located in a gas supply line 30, in order to acquire a signal sent by the gas analyser 20 and in order to send information to or acquire information from the control valve 50 in the gas supply line 30.

[0035] The gas analyser 20 is connected to the gas supply line 30 of a natural gas burner 40; this connection enables the gas analyser 20 to take a sample from the gas supply line 30, i.e. to acquire a sample of natural gas burned in the natural gas burner 40.

[0036] The gas analyser 20 analyses the sampled natural gas, to acquire a measurement result for each type of gas component contained in the natural gas, and a corresponding content. Here, the analysis may be carried out by two methods: in the first, based on a preset gas component, the content of the gas contained in the natural gas is analysed, e.g. preferably, the hydrogen content of the natural gas is preset and analysed, then the gas analyser 20 analyses and determines the content of hydrogen in the natural gas, e.g. the hydrogen content is 15%; in the second, the gas analyser 20 first analyses component categories of various gases contained in the natural gas, such as methane, ethane, carbon dioxide, nitrogen, hydrogen and hydrogen sulfide, then separately determines the gas content corresponding to each type of gas component on the basis of the analysed gas components.

[0037] The gas analyser 20 then sends the measurement result to the combustion controller 10.

[0038] After acquiring the measurement result, the combustion controller 10 inputs the measurement result as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result. The control model is related to a gas component in the natural gas and a corresponding content. For example, the control model may directly include different control information items corresponding to different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0039] Those skilled in the art will understand that the control model may be presented in the form of a two-dimensional or multi-dimensional curve, e.g. with a horizontal coordinate axis as a hydrogen content value, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0040] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on a feedback signal. Here, the feedback signal may be various types of sensor signal mentioned below.

[0041] The combustion controller 10 adjusts a flow rate of natural gas in the gas supply line 30 of the natural gas burner 40 by adjusting the control valve 50 according to the control information. Here, those skilled in the art will understand that in addition to adjustment of the control valve 50, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0042] Preferably, the combustion controller 10 may also determine a current corresponding risk level according to the measurement result, e.g. a high risk level, medium risk level or low risk level. Taking the measurement of hydrogen content as an example:

if the hydrogen content exceeds a normal limit and reaches the low risk level, alarm information is sent;

if the hydrogen content exceeds the normal limit and reaches the medium risk level, shutdown of the natural gas burner 40 is triggered;

if the hydrogen content exceeds the normal limit and reaches the high risk level, tripping of the natural gas burner 40 is triggered.

[0043] Preferably, the combustion controller 10 may also combine with another signal to determine the current corresponding risk level and trigger a corresponding operation. For example, if the hydrogen content exceeds the normal limit and reaches the high risk level, and at the same time the roar of the natural gas burner 40 exceeds a certain level for a certain period of time, then tripping of the natural gas burner 40 is triggered. The roar may be acquired by placing a roar sensor on the natural gas burner 40.

[0044] Fig. 2 shows an architecture diagram of a natural gas combustion system using a natural gas combustion control system in another embodiment of the present invention. The natural gas combustion control system comprises a combustion controller 10, a gas analyser 20, a temperature sensor 701, a temperature sensor 702, a dynamic sensor 80 and an emission sensor 90. The system architecture shown in fig. 2 is merely one example of the use of a natural gas combustion control system; the system architecture may be used in a gas turbine using a premix burner.

[0045] The combustion controller 10 is connected by wired or wireless connection to the gas analyser 20 and to a control valve 50 located in a gas supply line 30, in order to acquire a signal sent by the gas analyser 20 and in order to send information to or acquire information from the control valve 50 in the gas supply line 30.

[0046] The gas analyser 20 is connected to the gas supply line 30 of a natural gas burner 40; this connection enables the gas analyser 20 to take a sample from the gas supply line 30, i.e. to acquire a sample of natural gas burned in the natural gas burner 40.

[0047] The gas analyser 20 analyses the sampled natural gas, to acquire a measurement result for each type of gas component contained in the natural gas, and a corresponding content. Here, the analysis may be carried out by two methods: in the first, based on a preset gas component, the content of the gas contained in the natural gas is analysed, e.g. preferably, the hydrogen content of the natural gas is preset and analysed, then the gas analyser 20 analyses and determines the content of hydrogen in the natural gas, e.g. the hydrogen content is 15%; in the second, the gas analyser 20 first analyses component categories of various gases contained in the natural gas, such as methane, ethane, carbon dioxide, nitrogen, hydrogen and hydrogen sulfide, then separately determines the gas content corresponding to each type of gas component on the basis of the analysed gas components.

[0048] The gas analyser 20 then sends the measurement result to the combustion controller 10.

[0049] The temperature sensors 701 and 702 are located on the natural gas burner 40, to measure burner temperature; the temperature sensors may be any apparatuses capable of measuring natural gas burner temperature, such as thermocouples.

[0050] The emission sensor 90 is arranged downstream of the natural gas burner 40; here, those skilled in the art will understand the arrangement position of the emission sensor. The emission sensor 90 can measure combustion emission gases of the natural gas burner 40.

[0051] The dynamic sensor 80 is arranged in a combustion chamber of the natural gas burner, and can measure a combustion dynamic situation in the combustion chamber. For the sake of simplicity and clarity, no specific combustion chamber is shown in the drawing, and the position of the dynamic sensor 80 in the drawing is purely schematic; those skilled in the art will understand the arrangement position of the dynamic sensor 80.

[0052] Here, the quantities of the temperature sensors, the emission sensor and the dynamic sensor are purely schematic, and do not indicate that it is only possible to arrange individual sensors at the corresponding positions. Those skilled in the art may arrange two or more sensors of the same type for each system or each burner, based on actual needs. In addition, one or more types of the three types of sensor mentioned above may be arranged on the burner.

[0053] Here, those skilled in the art will understand that for the sake of convenience of explanation and clarity, fig. 2 shows a two-stage natural gas burner 40 and corresponding complementary apparatuses; for example, a control valve 601, a control valve 602, manifold ring piping 1001, manifold ring piping 1002, a distribution branch 301 and a distribution branch 302, etc. The natural gas combustion system architecture may include a single-stage or a multi-stage (two or more stages) natural gas burner and corresponding complementary apparatuses, such as a combustion controller, a gas analyser and various types of sensor.

[0054] Preferably, if the natural gas combustion system architecture shown in fig. 2 is used in a gas turbine, the control valve 601 and the control valve 602 may be control apparatuses for controlling premix gas and duty gas respectively.

[0055] The temperature sensor 701 and the temperature sensor 702 transmit corresponding temperature signals to the combustion controller 10, the dynamic sensor 80 transmits a corresponding dynamic signal to the combustion controller 10, and the emission sensor 90 transmits a corresponding emission signal to the combustion controller 10; correspondingly, the combustion controller 10 acquires at least any one of the abovementioned signals, and uses it as a feedback signal.

[0056] The combustion controller 10 then inputs the measurement result and the feedback signal as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result and the feedback signal. The control model is related to a gas component in the natural gas and a corresponding content, and the feedback signal.

[0057] For example, the control model may directly include different control information items corresponding to different feedback signals, for different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different feedback signals and different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0058] Those skilled in the art will understand that the control model may be presented in the form of a multi-dimensional curve, e.g. with one horizontal coordinate axis as a hydrogen content value, one or more other horizontal coordinate axes as a value of one type of feedback signal respectively, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0059] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on the feedback signal.

[0060] Preferably, control logic of the control model is also related to the arrangement position of the sensor. The control logic is a logic which determines, on the basis of a given input (i.e. the type of the feedback signal and a corresponding value), a corresponding output (i.e. corresponding control information). In the case where the arrangement positions of the sensors are different, control information items corresponding to the same feedback signals are different.

[0061] For example, if the position of the temperature sensor 701 on the natural gas burner 40 is closer to a flame than the position of the temperature sensor 702 on the natural gas burner 40, the control model for the temperature sensor 701 is different from the control model for the temperature sensor 702, e.g. an alarm temperature of the former will be higher than an alarm temperature of the latter, etc.

[0062] On the basis of the control information, the combustion controller 10 adjusts a flow rate of natural gas in the gas supply line 30 of the natural gas burner 40 by adjusting at least one of the control valve 50, the control valve 601 and the control valve 602. Here, those skilled in the art will understand that in addition to adjustment of the control valve 50, the control valve 601 and the control valve 602, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0063] Preferably, one or more sensor of each type is arranged on one said natural gas burner, and if at least any one of each type of arranged sensor fails, then the combustion controller 10 triggers alarm information.

[0064] Taking fig. 10 as an example, fig. 10 shows a schematic diagram of a natural gas burner including two sensors according to an embodiment of the present invention. Two temperature sensors 701 and 702 are arranged on the natural gas burner 40, and jointly detect a temperature of the natural gas burner. If one of the temperature sensors, e.g. temperature sensor 701, fails, then the combustion controller 10 no longer acquires a temperature signal from the temperature sensor 701, and therefore determines that the temperature sensor 701 has failed, and issues alarm information.

[0065] Preferably, when the combustion controller 10 also acquires the feedback signal, the combustion controller 10 can determine a current corresponding risk level according to a gas component in the measurement result and a corresponding content, in combination with the feedback signal. For example, if the hydrogen content exceeds a normal limit, and at the same time an emission signal of the emission sensor 90 shows that an emission content is excessive, then it can be determined that the current corresponding risk level is a medium risk level; if the hydrogen content exceeds the normal limit, and at the same time the emission signal of the emission sensor 90 shows that the emission content is excessive and a temperature signal of the temperature sensor 701 or 702 shows a high temperature, then it can be determined that the current corresponding risk level is a high risk level; or if a value of the hydrogen content exceeding the normal limit is very high, and at the same time the temperature signal of the temperature sensor 701 or 702 shows a high temperature, then it can be determined that the current corresponding risk level is the high risk level.

[0066] Here, those skilled in the art will understand that the explanation above is merely given by way of example, and is not a limitation on the present invention; other manners of combining to determine risk level are likewise suitable for the present invention, and are included in the scope of protection of the present invention.

[0067] Fig. 3 is a block diagram of a combustion controller according to an embodiment of the present invention. The combustion controller 10 comprises an acquisition unit 101, a determining unit 102 and an adjustment unit 103.

[0068] The acquisition unit 101 acquires a measurement result for natural gas in a gas supply line of the natural gas burner, wherein the measurement result comprises a gas component in the natural gas, and a corresponding content.

[0069] The acquisition unit 101 may interact with a device such as a gas analyser, to acquire a measurement result sent by the gas analyser; in addition, the acquisition unit 101 may also interact with another device capable of providing the measurement result, to acquire the measurement result.

[0070] After acquiring the measurement result, the acquisition unit 101 sends the measurement result into the determining unit 102. The determining unit 102 inputs the measurement result as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result. The control model is related to a gas component in the natural gas and a corresponding content. For example, the control model may directly include different control information items corresponding to different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0071] Those skilled in the art will understand that the control model may be presented in the form of a two-dimensional or multi-dimensional curve, e.g. with a horizontal coordinate axis as a hydrogen content value, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0072] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on a feedback signal.

[0073] The determining unit 102 sends the control information into the adjustment unit 103; the adjustment unit 103 adjusts a flow rate of natural gas in the gas supply line of the natural gas burner by adjusting a control valve for example located on the gas supply line of the natural gas burner, according to the control information. Here, those skilled in the art will understand that in addition to adjustment of the control valve, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0074] Fig. 4 is a block diagram of a combustion controller according to another embodiment of the present invention. The combustion controller 10 comprises an acquisition unit 101, a determining unit 102, an adjustment unit 103 and a feedback unit 104.

[0075] The acquisition unit 101 and the adjustment unit 103 are identical or similar to the corresponding apparatuses shown in fig. 3, so are not described again superfluously here, and are included here by reference.

[0076] The feedback unit 104, by interacting with a sensor corresponding to the natural gas burner or another device capable of providing a corresponding signal, acquires at least any one of a dynamic signal of a dynamic sensor of the natural gas burner, an emission signal of an emission sensor and a temperature signal of a temperature sensor, to serve as a feedback signal.

[0077] The determining unit 102 then acquires the measurement result sent by the acquisition unit 101, and acquires the feedback signal sent by the feedback unit 104, inputs the measurement result and the feedback signal as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result and the feedback signal. The control model is related to a gas component in the natural gas and a corresponding content, and the feedback signal.

[0078] For example, the control model may directly include different control information items corresponding to different feedback signals, for different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different feedback signals and different natural gas gas components and contents, and the determining unit 102 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0079] Those skilled in the art will understand that the control model may be presented in the form of a multi-dimensional curve, e.g. with one horizontal coordinate axis as a hydrogen content value, one or more other horizontal coordinate axes as a value of one type of feedback signal respectively, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0080] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on the feedback signal.

[0081] Preferably, control logic of the control model is also related to the arrangement position of the sensor. The control logic is a logic which determines, on the basis of a given input (i.e. the type of the feedback signal and a corresponding value), a corresponding output (i.e. corresponding control information). In the case where the arrangement positions of the sensors are different, control information items corresponding to the same feedback signals are different.

[0082] For example, if the position of a certain temperature sensor on the natural gas burner is closer to a flame than the position of another temperature sensor on the natural gas burner, the control model for the former is different from the control model for the latter, e.g. an alarm temperature of the former will be higher than an alarm temperature of the latter, etc.

[0083] Preferably, the combustion controller 10 further comprises an alarm unit (not shown), wherein if one or more sensor of each type is arranged on the natural gas burner corresponding to the combustion controller 10, then the alarm unit is used for triggering alarm information if at least any one of each type of arranged sensor fails.

[0084] Taking fig. 10 as an example, fig. 10 shows a schematic diagram of a natural gas burner including two sensors according to an embodiment of the present invention. Two temperature sensors 701 and 702 are arranged on the natural gas burner 40, and jointly detect a temperature of the natural gas burner. If one of the temperature sensors, e.g. temperature sensor 701, fails, then the combustion controller 10 no longer acquires a temperature signal from the temperature sensor 701, and therefore determines that the temperature sensor 701 has failed, and the alarm unit issues alarm information.

[0085] Fig. 5 is a block diagram of a combustion controller according to another embodiment of the present invention. The combustion controller 10 comprises an acquisition unit 101, a determining unit 102, an adjustment unit 103, a feedback unit 104, a risk control unit 105 and a triggering unit 106.

[0086] The acquisition unit 101, determining unit 102, adjustment unit 103 and feedback unit 104 are identical or similar to the corresponding apparatuses shown in fig. 3 or fig. 4, so are not described again superfluously here, and are included here by reference.

[0087] The risk control unit 105 can acquire the measurement result from the acquisition unit 101, and determine, on the basis of the measurement result, a current corresponding risk level, e.g. a high risk level, a medium risk level or a low risk level.

[0088] On the basis of the risk level, the trigger unit 106 triggers an operation corresponding to the risk level.

[0089] Taking as an example the measurement of hydrogen content:

> if the hydrogen content exceeds a normal limit and reaches the low risk level, alarm information is sent;
>
> if the hydrogen content exceeds the normal limit and reaches the medium risk level, shutdown of the natural gas burner is triggered;
>
> if the hydrogen content exceeds the normal limit and reaches the high risk level, tripping of the natural gas burner is triggered.

[0090] Preferably, the combustion controller 10 may also combine with another signal to determine the current corresponding risk level and trigger a corresponding operation. For example, if the hydrogen content exceeds the normal limit and reaches the high risk level, and at the same time the roar of the natural gas burner exceeds a certain level for a certain period of time, then tripping of the natural gas burner is triggered. The roar may be acquired by placing a roar sensor on the natural gas burner.

[0091] Preferably, when the risk control unit 105 also acquires the feedback signal (not shown in the figure), the risk control unit 105 can determine a current corresponding risk level according to a gas component in the measurement result and a corresponding content, in combination with the feedback signal. For example, if the hydrogen content exceeds a normal limit, and at the same time an emission signal of an emission sensor shows that an emission content is excessive, then it can be determined that the current corresponding risk level is the medium risk level; if the hydrogen content exceeds the normal limit, and at the same time the emission signal of the emission sensor shows that the emission content is excessive and a temperature signal of a temperature sensor shows a high temperature, then it can be determined that the current corresponding risk level is a high risk level; or if a value of the hydrogen content exceeding the normal limit is very high, and at the same time the temperature signal of the temperature sensor shows a high temperature, then it can be determined that the current corresponding risk level is the high risk level.

[0092] Here, those skilled in the art will understand that the explanation above is merely given by way of example, and is not a limitation on the present invention; other manners of combining to determine risk level are likewise suitable for the present invention, and are included in the scope of protection of the present invention.

[0093] Each unit in figs. 3 - 5 may be realized using software, hardware (e.g. integrated circuits, FPGA (Field-Programmable Gate Array), etc.), or a combination of software and hardware.

[0094] Reference is now made to fig. 11, which shows a structural diagram of a combustion controller according to an embodiment of the present invention. As shown in fig. 11, the combustion controller 10 may comprise a memory 1101 and a processor 1102. The memory 1101 may store an executable instruction. The processor 1102 may realize an operation executed by each unit in figs. 3-5, according to the executable instruction stored in the memory 1101.

[0095] In addition, an embodiment of the present invention also provides a machine-readable medium, on which is stored an executable instruction which, when executed, causes a machine to execute the operation realized by the processor 1102.

[0096] Fig. 6 is a system flow chart of a combustion controller control method using a natural gas combustion control system according to an embodiment of the present invention.

[0097] The natural gas combustion control system comprises a combustion controller 10 and a gas analyser 20.

[0098] Referring to fig. 1, fig. 1 shows a system architecture diagram of a natural gas combustion control system. The combustion controller 10 is connected by wired or wireless connection to the gas analyser 20 and to a control valve 50 located in a gas supply line 30, in order to acquire a signal sent by the gas analyser 20 and in order to send information to or acquire information from the control valve 50 in the gas supply line 30.

[0099] The gas analyser 20 is connected to the gas supply line 30 of a natural gas burner 40; this connection enables the gas analyser 20 to take a sample from the gas supply line 30, i.e. to acquire a sample of natural gas burned in the natural gas burner 40.

[0100] In step S1, the gas analyser 20 analyses the sampled natural gas, to acquire a measurement result for each type of gas component contained in the natural gas, and a corresponding content. Here, the analysis may be carried out by two methods: in the first, based on a preset gas component, the content of the gas contained in the natural gas is analysed, e.g. preferably, the hydrogen content of the natural gas is preset and analysed, then the gas analyser 20 analyses and determines the content of hydrogen in the natural gas, e.g. the hydrogen content is 15%; in the second, the gas analyser 20 first analyses component categories of various gases contained in the natural gas, such as methane, ethane, carbon dioxide, nitrogen, hydrogen and hydrogen sulfide, then separately determines the gas content corresponding to each type of gas component on the basis of the analysed gas components.

[0101] Then in step S2, the gas analyser 20 sends the measurement result to the combustion controller 10.

[0102] In step S3, after acquiring the measurement result, the combustion controller 10 inputs the measurement result as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result. The control model is related to a gas component in the natural gas and a corresponding content. For example, the control model may directly include different control information items corresponding to different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0103] Those skilled in the art will understand that the control model may be presented in the form of a two-dimensional or multi-dimensional curve, e.g. with a horizontal coordinate axis as a hydrogen content value, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0104] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on a feedback signal. Here, the feedback signal may be various types of sensor signal mentioned below.

[0105] In step S4, the combustion controller 10 adjusts a flow rate of natural gas in the gas supply line 30 of the natural gas burner 40 by adjusting the control valve 50 according to the control information. Here, those skilled in the art will understand that in addition to adjustment of the control valve 50, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0106] Preferably, the method also comprises a step of determining a risk level (not shown): specifically, the combustion controller 10 determines a current corresponding risk level according to the measurement result, e.g. a high risk level, medium risk level or low risk level. Taking the measurement of hydrogen content as an example:

if the hydrogen content exceeds a normal limit and reaches the low risk level, alarm information is sent;

if the hydrogen content exceeds the normal limit and reaches the medium risk level, shutdown of the natural gas burner 40 is triggered;

if the hydrogen content exceeds the normal limit and reaches the high risk level, tripping of the natural gas burner 40 is triggered.

[0107] Preferably, the method also comprises a step of combining with another signal to determine the risk level and triggering a corresponding operation (not shown): specifically, the combustion controller 10 may also combine with another signal to determine the current corresponding risk level and trigger the corresponding operation. For example, if the hydrogen content exceeds the normal limit and reaches the high risk level, and at the same time the roar of the natural gas burner 40 exceeds a certain level for a certain period of time, then tripping of the natural gas burner 40 is triggered. The roar may be acquired by placing a roar sensor on the natural gas burner 40.

[0108] Preferably, taking fig. 2 as an example, the natural gas combustion control system comprises the combustion controller 10, gas analyser 20, temperature sensor 701, temperature sensor 702, dynamic sensor 80 and emission sensor 90.

[0109] The temperature sensors 701 and 702 are located on the natural gas burner 40, to measure burner temperature; the temperature sensors may be any apparatuses capable of measuring natural gas burner temperature, such as thermocouples.

[0110] The emission sensor 90 is arranged downstream of the natural gas burner 40; here, those skilled in the art will understand the arrangement position of the emission sensor. The emission sensor 90 can measure combustion emission gases of the natural gas burner 40.

[0111] The dynamic sensor 80 is arranged in a combustion chamber of the natural gas burner, and can measure a combustion dynamic situation in the combustion chamber. For the sake of simplicity and clarity, no specific combustion chamber is shown in the drawing, and the position of the dynamic sensor 80 in the drawing is purely schematic; those skilled in the art will understand the arrangement position of the dynamic sensor 80.

[0112] Here, the quantities of the temperature sensors, the emission sensor and the dynamic sensor are purely schematic, and do not indicate that it is only possible to arrange individual sensors at the corresponding positions. Those skilled in the art may arrange two or more sensors of the same type for each system or each burner, based on actual needs. In addition, one or more types of the three types of sensor mentioned above may be arranged on the burner.

[0113] Here, those skilled in the art will understand that for the sake of convenience of explanation and clarity, fig. 2 shows a two-stage natural gas burner 40 and corresponding complementary apparatuses; for example, the control valve 601, control valve 602, manifold ring piping 1001, manifold ring piping 1002, distribution branch 301 and distribution branch 302, etc. The natural gas combustion system architecture may include a single-stage or a multi-stage (two or more stages) natural gas burner and corresponding complementary apparatuses, such as a combustion controller, a gas analyser and various types of sensor.

[0114] If the natural gas combustion control system comprises a sensor, then the system method may also comprise a step of acquiring a feedback signal (not shown): specifically, the temperature sensor 701 and the temperature sensor 702 transmit corresponding temperature signals to the combustion controller 10, the dynamic sensor 80 transmits a corresponding dynamic signal to the combustion controller 10, and the emission sensor 90 transmits a corresponding emission signal to the combustion controller 10; correspondingly, the combustion controller 10 acquires at least any one of the abovementioned signals, and uses it as a feedback signal.

[0115] Then in step S3, the combustion controller 10 inputs the measurement result and the feedback signal as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result and the feedback signal. The control model is related to a gas component in the natural gas and a corresponding content, and the feedback signal.

[0116] For example, the control model may directly include different control information items corresponding to different feedback signals, for different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different feedback signals and different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0117] Those skilled in the art will understand that the control model may be presented in the form of a multi-dimensional curve, e.g. with one horizontal coordinate axis as a hydrogen content value, one or more other horizontal coordinate axes as a value of one type of feedback signal respectively, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0118] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on the feedback signal.

[0119] Preferably, control logic of the control model is also related to the arrangement position of the sensor. The control logic is a logic which determines, on the basis of a given input (i.e. the type of the feedback signal and a corresponding value), a corresponding output (i.e. corresponding control information). In the case where the arrangement positions of the sensors are different, control information items corresponding to the same feedback signals are different.

[0120] For example, if the position of the temperature sensor 701 on the natural gas burner 40 is closer to a flame than the position of the temperature sensor 702 on the natural gas burner 40, the control model for the temperature sensor 701 is different from the control model for the temperature sensor 702, e.g. an alarm temperature of the former will be higher than an alarm temperature of the latter, etc.

[0121] In step S4, on the basis of the control information, the combustion controller 10 adjusts a flow rate of natural gas in the gas supply line 30 of the natural gas burner 40 by adjusting at least one of the control valve 50, the control valve 601 and the control valve 602. Here, those skilled in the art will understand that in addition to adjustment of the control valve 50, the control valve 601 and the control valve 602, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0122] Preferably, the method also comprises a step of triggering alarm information (not shown); specifically, one or more sensor of each type is arranged on one said natural gas burner, and if at least any one of each type of arranged sensor fails, then the combustion controller 10 triggers alarm information.

[0123] Taking fig. 10 as an example, fig. 10 shows a schematic diagram of a natural gas burner including two sensors according to an embodiment of the present invention. Two temperature sensors 701 and 702 are arranged on the natural gas burner 40, and jointly detect a temperature of the natural gas burner. If one of the temperature sensors, e.g. temperature sensor 701, fails, then the combustion controller 10 no longer acquires a temperature signal from the temperature sensor 701, and therefore determines that the temperature sensor 701 has failed, and issues alarm information.

[0124] Preferably, the method also comprises a step of determining a risk level in combination with the feedback signal (not shown); specifically, when the combustion controller 10 also acquires the feedback signal, the combustion controller 10 can determine a current corresponding risk level according to a gas component in the measurement result and a corresponding content, in combination with the feedback signal. For example, if the hydrogen content exceeds a normal limit, and at the same time an emission signal of the emission sensor 90 shows that an emission content is excessive, then it can be determined that the current corresponding risk level is a medium risk level; if the hydrogen content exceeds the normal limit, and at the same time the emission signal of the emission sensor 90 shows that the emission content is excessive and a temperature signal of the temperature sensor 701 or 702 shows a high temperature, then it can be determined that the current corresponding risk level is a high risk level; or if a value of the hydrogen content exceeding the normal limit is very high, and at the same time the temperature signal of the temperature sensor 701 or 702 shows a high temperature, then it can be determined that the current corresponding risk level is the high risk level.

[0125] Here, those skilled in the art will understand that the explanation above is merely given by way of example, and is not a limitation on the present invention; other manners of combining to determine risk level are likewise suitable for the present invention, and are included in the scope of protection of the present invention.

[0126] Fig. 7 is a flow chart of a combustion controller control method according to an embodiment of the present invention.

[0127] In step S101, the combustion controller 10 acquires a measurement result for natural gas in a gas supply line of the natural gas burner, wherein the measurement result comprises a gas component in the natural gas, and a corresponding content.

[0128] The combustion controller 10 may interact with a device such as a gas analyser, to acquire a measurement result sent by the gas analyser; in addition, the combustion controller 10 may also interact with another device capable of providing the measurement result, to acquire the measurement result.

[0129] In step S101, after the combustion controller 10 has acquired the measurement result, step S102 is performed. In step S102, the combustion controller 10 inputs the measurement result as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result. The control model is related to a gas component in the natural gas and a corresponding content. For example, the control model may directly include different control information items corresponding to different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different natural gas gas components and contents, and the combustion controller 10 then determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0130] Those skilled in the art will understand that the control model may be presented in the form of a two-dimensional or multi-dimensional curve, e.g. with a horizontal coordinate axis as a hydrogen content value, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0131] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on a feedback signal.

[0132] Step S103 is then performed; in step S103, the combustion controller 10 adjusts a flow rate of natural gas in the gas supply line of the natural gas burner by adjusting a control valve for example located on the gas supply line of the natural gas burner, according to the control information. Here, those skilled in the art will understand that in addition to adjustment of the control valve, other manners of adjustment, if suitable for the present invention, are likewise included in the scope of protection of the present invention and included here by reference.

[0133] Fig. 8 is a flow chart of a combustion controller control method according to another embodiment of the present invention.

[0134] Step S101 and step S103 are identical or similar to the corresponding steps shown in fig. 7, so are not described again superfluously here, and are included here by reference.

[0135] In step S104, by interacting with a sensor corresponding to the natural gas burner or another device capable of providing a corresponding signal, the combustion controller 10 acquires at least any one of a dynamic signal of a dynamic sensor of the natural gas burner, an emission signal of an emission sensor and a temperature signal of a temperature sensor, to serve as a feedback signal.

[0136] Then, step S102 acquires the measurement result sent by step S101, and acquires the feedback signal sent by step S104, inputs the measurement result and the feedback signal as input data into a preset control model, and on the basis of an output result of the control model for the input data, directly or indirectly determines control information corresponding to the measurement result and the feedback signal. The control model is related to a gas component in the natural gas and a corresponding content, and the feedback signal.

[0137] For example, the control model may directly include different control information items corresponding to different feedback signals, for different natural gas gas components and contents; or the control model includes different gas intake flow rates etc. corresponding to different feedback signals and different natural gas gas components and contents, and then in step S102, the combustion controller 10 determines corresponding control information according to the gas intake flow rate, e.g. increasing flow rate or decreasing flow rate, etc.

[0138] Those skilled in the art will understand that the control model may be presented in the form of a multi-dimensional curve, e.g. with one horizontal coordinate axis as a hydrogen content value, one or more other horizontal coordinate axes as a value of one type of feedback signal respectively, and a vertical coordinate axis as a natural gas flow rate value, etc.; or may be a table or another form of presentation.

[0139] Determination of the control model may be carried out in two ways: firstly, based on manual setting; secondly, on the basis of a default setting, performing real-time adjustment based on the feedback signal.

[0140] Preferably, control logic of the control model is also related to the arrangement position of the sensor. The control logic is a logic which determines, on the basis of a given input (i.e. the type of the feedback signal and a corresponding value), a corresponding output (i.e. corresponding control information). In the case where the arrangement positions of the sensors are different, control information items corresponding to the same feedback signals are different.

[0141] For example, if the position of a certain temperature sensor on the natural gas burner is closer to a flame than the position of another temperature sensor on the natural gas burner, the control model for the former is different from the control model for the latter, e.g. an alarm temperature of the former will be higher than an alarm temperature of the latter, etc.

[0142] Preferably, the method also comprises a step of triggering alarm information (not shown); specifically, in this step, if one or more sensor of each type is arranged on the natural gas burner corresponding to the combustion controller 10, then the combustion controller 10 triggers alarm information if at least any one of each type of arranged sensor fails.

[0143] Taking fig. 10 as an example, fig. 10 shows a schematic diagram of a natural gas burner including two sensors according to an embodiment of the present invention. Two temperature sensors 701 and 702 are arranged on the natural gas burner 40, and jointly detect a temperature of the natural gas burner. If one of the temperature sensors, e.g. temperature sensor 701, fails, then the combustion controller 10 no longer acquires a temperature signal from the temperature sensor 701, and therefore determines that the temperature sensor 701 has failed, and the alarm unit issues alarm information.

[0144] Fig. 9 is a flow chart of a combustion controller control method according to another embodiment of the present invention.

[0145] Steps S101, S102, S103 and S104 are identical or similar to the corresponding steps shown in fig. 7 or fig. 8, so are not described again superfluously here, and are included here by reference.

[0146] In step S105, the combustion controller 10 can acquire the measurement result from step S101, and determine a current corresponding risk level according to the measurement result, e.g. a high risk level, medium risk level or low risk level.

[0147] In step S106, the combustion controller 10 triggers an operation corresponding to the risk level, on the basis of the risk level.

[0148] Taking the measurement of hydrogen content as an example:

if the hydrogen content exceeds a normal limit and reaches the low risk level, alarm information is sent;

if the hydrogen content exceeds the normal limit and reaches the medium risk level, shutdown of the natural gas burner is triggered;

if the hydrogen content exceeds the normal limit and reaches the high risk level, tripping of the natural gas burner is triggered.

[0149] Preferably, in step S105, the combustion controller 10 may also combine with another signal to determine the current corresponding risk level and trigger the corresponding operation. For example, if the hydrogen content exceeds the normal limit and reaches the high risk level, and at the same time the roar of the natural gas burner exceeds a certain level for a certain period of time, then tripping of the natural gas burner is triggered. The roar may be acquired by placing a roar sensor on the natural gas burner.

[0150] Preferably, when step S105 can also acquire the feedback signal from step S104 (not shown in the drawing), in step S105, the combustion controller 10 can determine a current corresponding risk level according to a gas component in the measurement result and a corresponding content, in combination with the feedback signal. For example, if the hydrogen content exceeds a normal limit, and at the same time an emission signal of the emission sensor shows that an emission content is excessive, then it can be determined that the current corresponding risk level is a medium risk level; if the hydrogen content exceeds the normal limit, and at the same time the emission signal of the emission sensor shows that the emission content is excessive and a temperature signal of the temperature sensor shows a high temperature, then it can be determined that the current corresponding risk level is a high risk level; or if a value of the hydrogen content exceeding the normal limit is very high, and at the same time the temperature signal of the temperature sensor shows a high temperature, then it can be determined that the current corresponding risk level is the high risk level.

[0151] Here, those skilled in the art will understand that the explanation above is merely given by way of example, and is not a limitation on the present invention; other manners of combining to determine risk level are likewise suitable for the present invention, and are included in the scope of protection of the present invention.

[0152] Those skilled in the art will understand that various alterations and changes may be made to the various embodiments disclosed above without departing from the substance of the invention. Thus, the scope of protection of the present invention shall be defined by the attached claims.

Claims

1. A method for monitoring combustion of a natural gas burner (40), wherein the natural gas burner (40) is connected to a gas supply line (30), the gas supply line (30) is connected to a natural gas combustion control system, and the natural gas combustion control system comprises a gas analyser (20) and a combustion controller (10), the method comprising:

   the gas analyser (20) taking a sample from the gas supply line (30), and analysing sampled natural gas to acquire a measurement result, wherein the measurement result comprises a gas component in the natural gas and a corresponding content;
   the gas analyser (20) sending the measurement result to the combustion controller (10);
   the combustion controller (10) inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content;
   the combustion controller (10) adjusting a flow rate of natural gas in the gas supply line (30) of the natural gas burner (40) according to the control information.

2. The method as claimed in claim 1, wherein the natural gas combustion control system further comprises at least any one of a dynamic sensor (80), an emission sensor (90) and a temperature sensor (701, 702), with the dynamic sensor (80) being arranged in a combustion chamber of the natural gas burner (40), the emission sensor (90) being arranged downstream of the natural gas burner (40), and the temperature sensor (701, 702) being arranged on the natural gas burner (40), the method further comprising:

   the combustion controller (10) acquiring at least any one of a dynamic signal of the dynamic sensor (80), an emission signal of the emission sensor (90) and a temperature signal of the temperature sensor (701, 702), to serve as a feedback signal;
   wherein the step of the combustion controller (10) determining control information comprises:
   the combustion controller (10) inputting the

measurement result and the feedback signal into a preset control model, to determine control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

3. The method as claimed in claim 1 or 2, wherein when the combustion controller (10) also acquires the feedback signal, the method further comprises:

the combustion controller (10) determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content, in combination with the feedback signal;
triggering an operation corresponding to the risk level.

4. A method for monitoring combustion of a natural gas burner (40) at a combustion controller (10) end, the method comprising:

acquiring a measurement result for natural gas in a gas supply line (30) of the natural gas burner (40), wherein the measurement result comprises a gas component in the natural gas and a corresponding content;
inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content;
adjusting a flow rate of natural gas in the gas supply line (30) of the natural gas burner (40) according to the control information.

5. The method as claimed in claim 4, wherein the method further comprises:

acquiring at least any one of a dynamic signal of a dynamic sensor (80) of the natural gas burner (40), an emission signal of an emission sensor (90) and a temperature signal of a temperature sensor (701, 702), to serve as a feedback signal;
wherein the step of determining control information comprises:
inputting the measurement result and the feedback signal into a preset control model, to acquire control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

6. The method as claimed in claim 4 or 5, wherein the method further comprises:

determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content;
triggering an operation corresponding to the risk level.

7. A natural gas combustion control system, wherein the natural gas combustion control system comprises a gas analyser (20) and a combustion controller (10);
the gas analyser (20) is connected to a gas supply line (30) of a natural gas burner (40), and the gas analyser (20) is used for taking a sample from the gas supply line (30); analysing sampled natural gas to acquire a measurement result, wherein the measurement result comprises a gas component in the natural gas and a corresponding content; and sending the measurement result to the combustion controller (10);
the combustion controller (10) comprises:

an acquisition unit (101), for acquiring the measurement result sent by the gas analyser (20);
a determining unit (102), for inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content;
an adjustment unit (103), for adjusting a flow rate of natural gas in the gas supply line (30) of the natural gas burner (40) according to the control information.

8. The natural gas combustion control system as claimed in claim 7, wherein the natural gas combustion control system further comprises at least any one of a dynamic sensor (80), an emission sensor (90) and a temperature sensor (701, 702), with the dynamic sensor (80) being arranged in a combustion chamber of the natural gas burner (40), the emission sensor (90) being arranged downstream of the natural gas burner (40), and the temperature sensor (701, 702) being arranged on the natural gas burner (40), and the combustion controller (10) further comprises:

a feedback unit (104), for acquiring at least any one of a dynamic signal of the dynamic sensor (80), an emission signal of the emission sensor (90) and a temperature signal of the temperature sensor (701, 702), to serve as a feedback signal;
wherein the determining unit (102) is used for:
inputting the measurement result and the feedback signal into a preset control model, to determine control information corresponding to the

measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

9. The natural gas combustion control system as claimed in claim 8, wherein control logic of the preset control model is also associated with an arrangement position of the sensor (80, 90, 701, 702).

10. The natural gas combustion control system as claimed in claim 8 or 9, wherein one or more sensor of each type is arranged on one said natural gas burner (40), wherein the combustion controller (10) further comprises:
an alarm unit, for triggering alarm information if at least any one of each type of arranged sensor fails.

11. The natural gas combustion control system as claimed in any one of claims 7 to 10, wherein the combustion controller (10) further comprises:

a risk control unit (105), for determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content;
a triggering unit (106), for triggering an operation corresponding to the risk level.

12. The natural gas combustion control system as claimed in claim 11, wherein when the combustion controller (10) further comprises the feedback unit (104), the risk control unit (105) is used for:
determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content, in combination with the feedback signal.

13. A combustion controller (10) for monitoring combustion of a natural gas burner (40), wherein the combustion controller (10) comprises:

an acquisition unit (101), for acquiring a measurement result for natural gas in a gas supply line (30) of the natural gas burner (40), wherein the measurement result comprises a gas component in the natural gas and a corresponding content;
a determining unit (102), for inputting the measurement result into a preset control model, to determine control information corresponding to the measurement result, wherein the control model is related to the gas component in the natural gas and the corresponding content;
an adjustment unit (103), for adjusting a flow rate of natural gas in the gas supply line (30) of the natural gas burner (40) according to the control information.

14. The combustion controller (10) as claimed in claim 13, wherein the combustion controller (10) further comprises:

a feedback unit (104), for acquiring at least any one of a dynamic signal of a dynamic sensor (80) of the natural gas burner (40), an emission signal of an emission sensor (90) and a temperature signal of a temperature sensor (701, 702), to serve as a feedback signal;
wherein the determining unit (102) is used for:
inputting the measurement result and the feedback signal into a preset control model, to acquire control information corresponding to the measurement result and the feedback signal, wherein the control model is related to the gas component in the natural gas and the corresponding content, and the feedback signal.

15. The combustion controller (10) as claimed in claim 13 or 14, wherein the combustion controller (10) further comprises:

a risk control unit (105), for determining a current corresponding risk level according to the gas component in the measurement result and the corresponding content;
a triggering unit (106), for triggering an operation corresponding to the risk level.

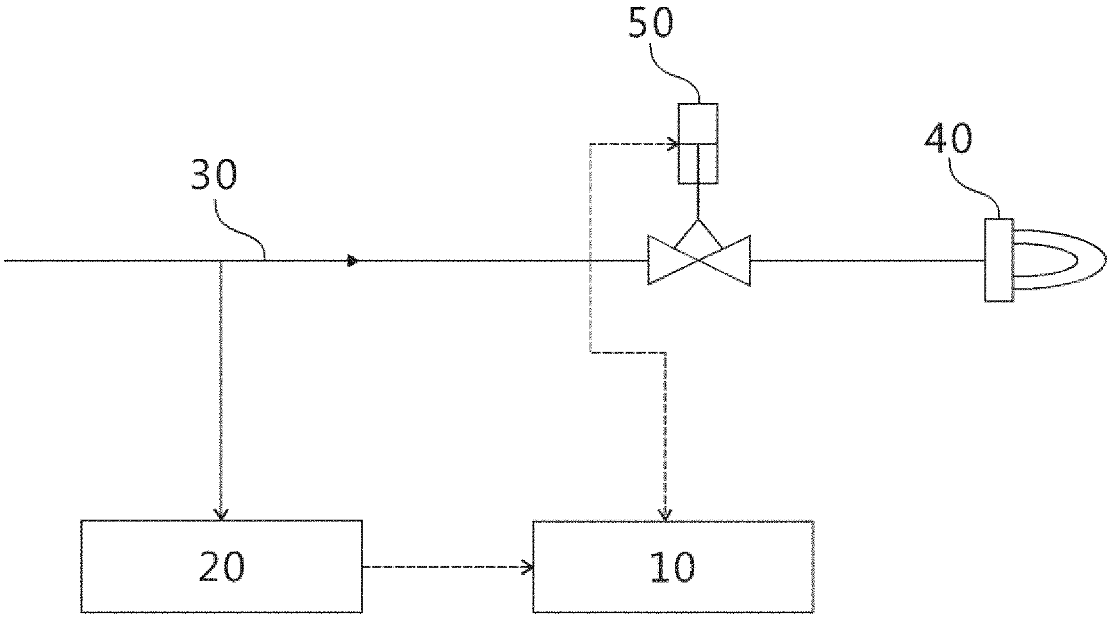

Fig.1

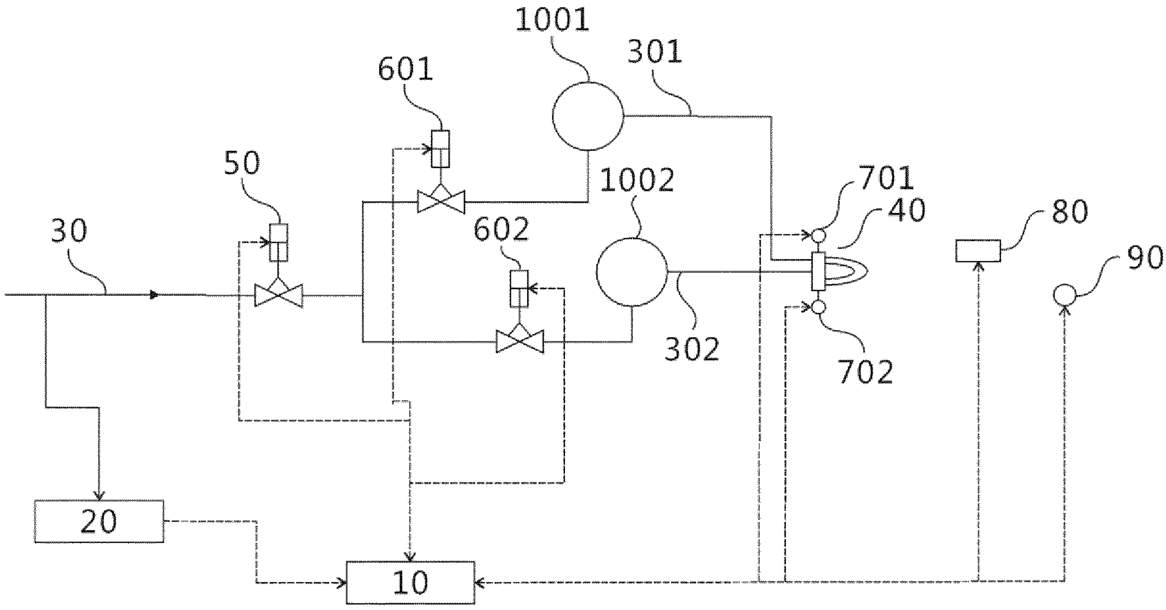

Fig.2

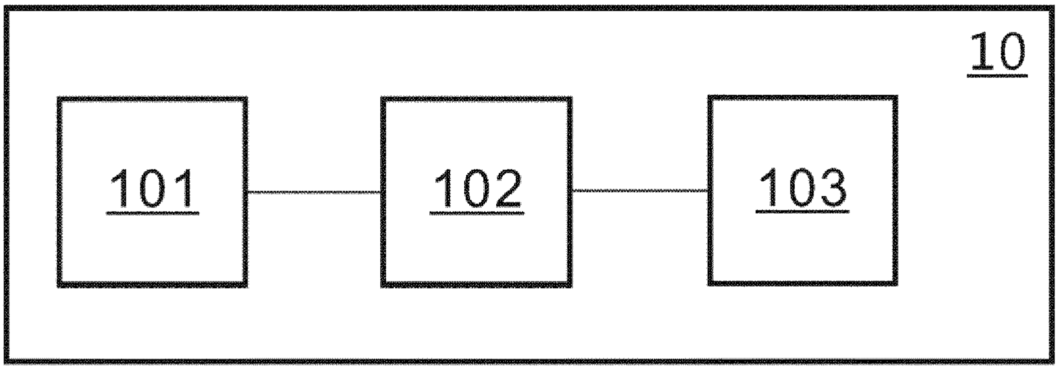

Fig. 3

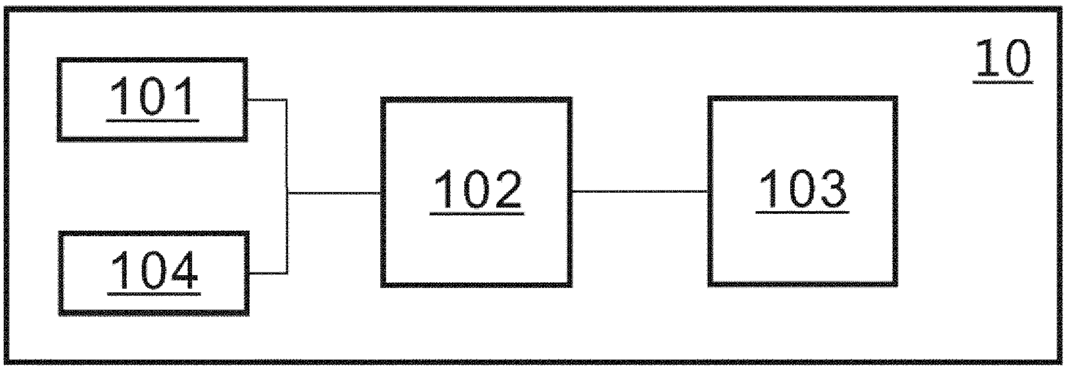

Fig. 4

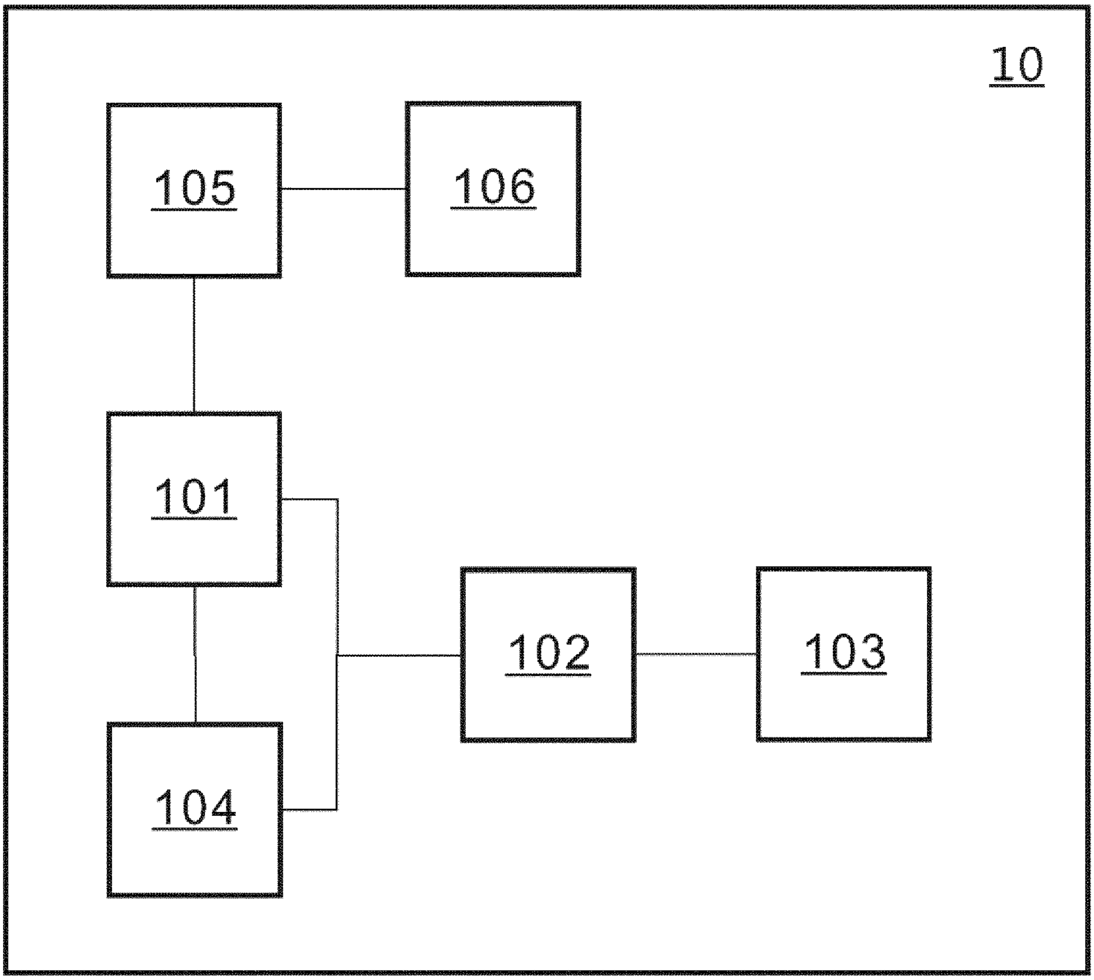

Fig.5

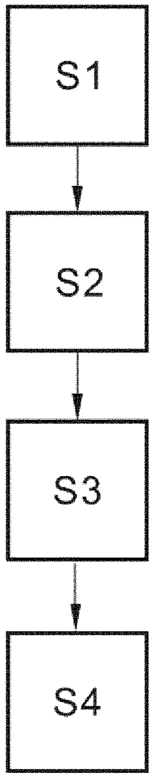

Fig.6

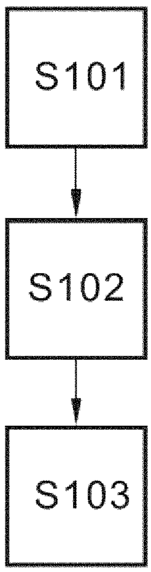

Fig.7

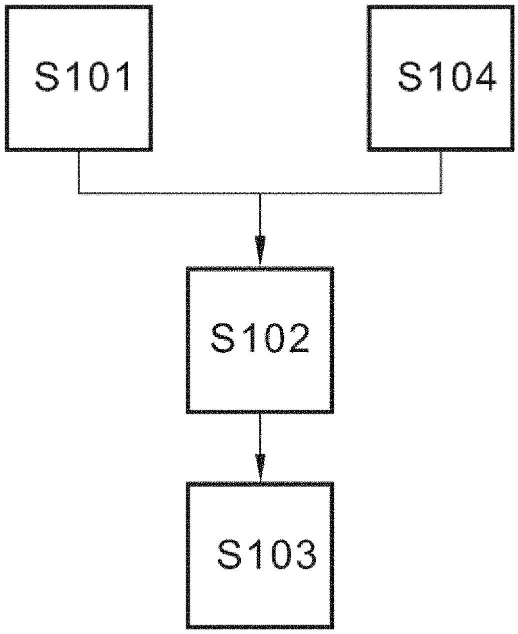

Fig.8

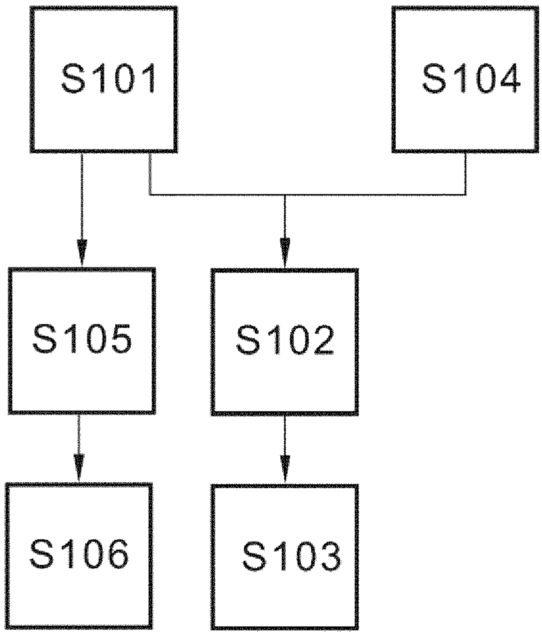

Fig.9

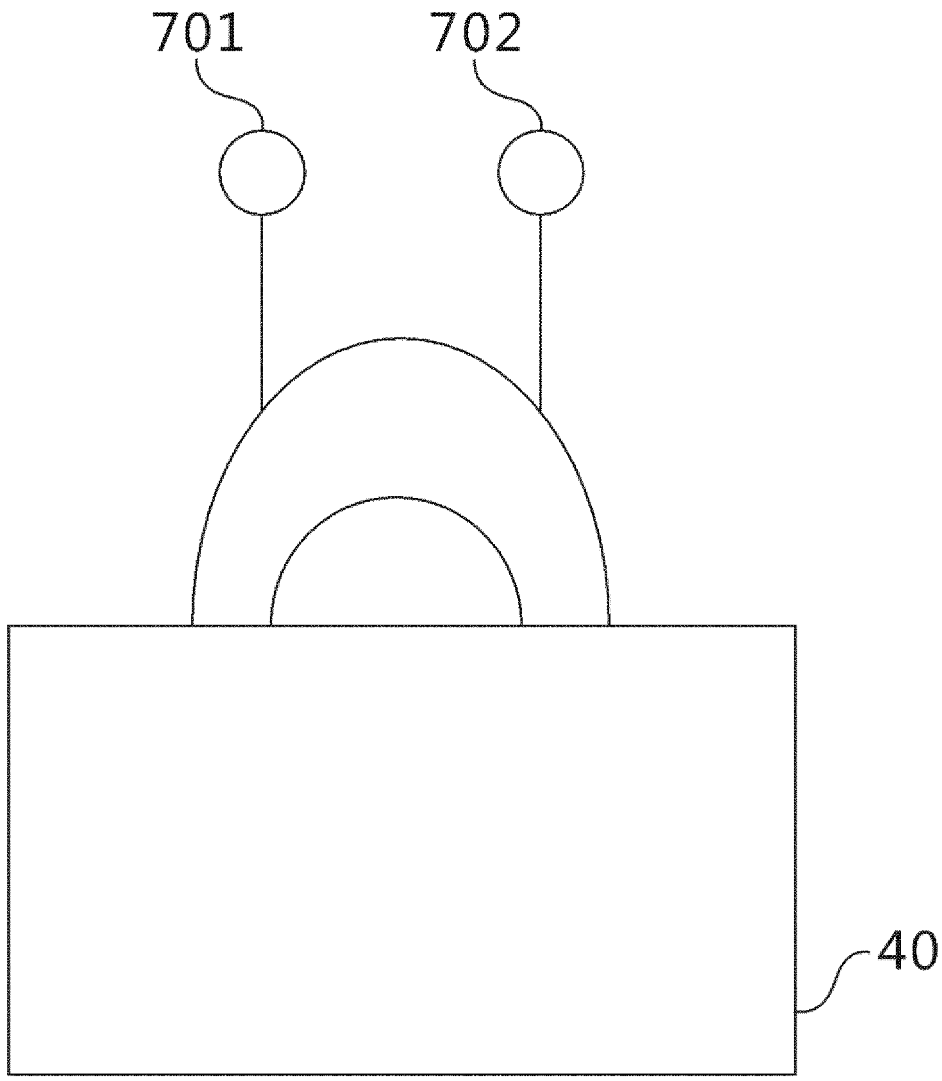

Fig.10

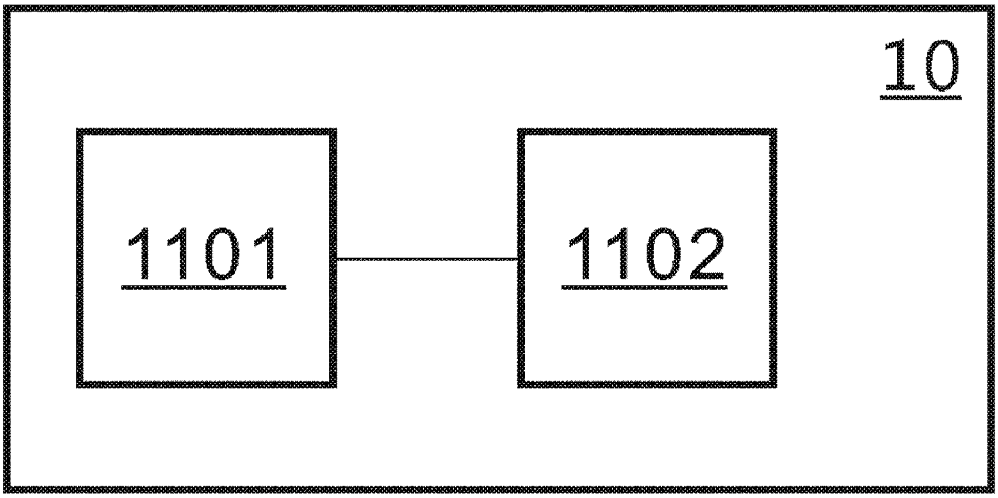

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/075984

A. CLASSIFICATION OF SUBJECT MATTER

F23N 5/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23N 5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, SIPOABS, DWPI, CNKI: explosion, blowback, flow rate, natural gas, component, content, control, security, danger, risk, blow, flow, velocity, rate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1623031 A (ALSTOM TECHNOLOGY LTD.), 01 June 2005 (01.06.2005), claim 1, description, page 2, paragraph 6 to page 4, paragraph 1, page 6, paragraph 11 to page 8, paragraph 1 and page 10, paragraph 2 to page 11, paragraph 1, and figures 1 and 6	1-15
X	DE 10308384 A1 (ALSTOM TECHNOLOGY LTD.), 09 September 2004 (09.09.2004), description, paragraphs [0014]-[0031], and figure 1	1-15
A	DE 19731209 A1 (STOCKBURGER, D.), 28 January 1999 (28.01.1999), the whole document	1-15
A	EP 1022514 A1 (SAINT GOBAIN VITRAGE et al.), 26 July 2000 (26.07.2000), the whole document	1-15
A	CN 101040148 A (SIEMENS AG), 19 September 2007 (19.09.2007), the whole document	1-15
A	US 6121628 A (SIEMENS WESTINGHOUSE POWER CORP.), 19 September 2000 (2000-09 19), the whole document	1-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 May 2017 (24.05.2017)	**12 June 2017 (12.06.2017)**

Name and mailing address of the ISA/CN	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	**WU, Yuying** Telephone No.: (86-10) **62089896**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/075984

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Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT
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International application No.
PCT/CN2017/075984

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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		DK 1022514 T3	27 October 2003
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		CN 101040148 B	02 July 2014
		AT 399964 T	15 July 2008
US 6121628 A	19 September 2000	None	

Form PCT/ISA/210 (patent family annex) (July 2009)