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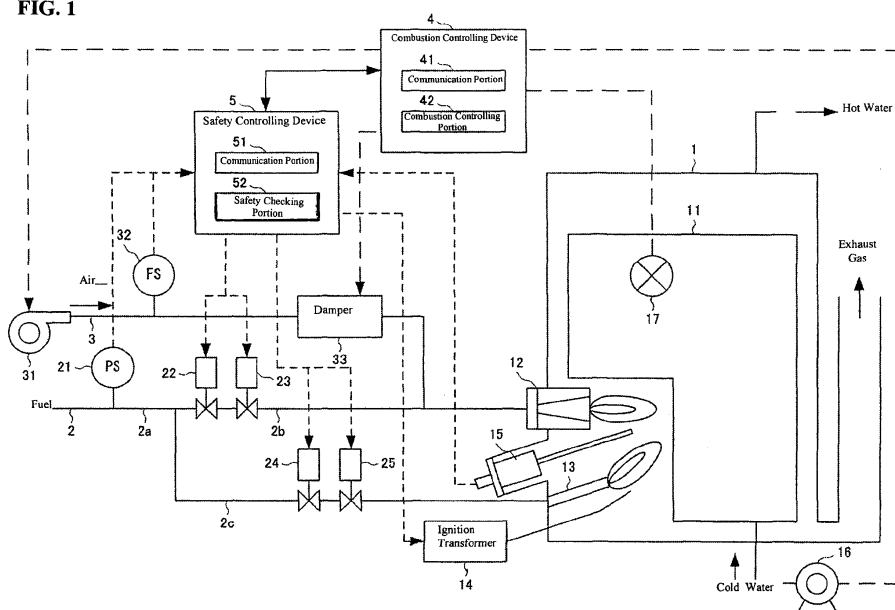
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(54) **Combustion controlling device**

(57) Two controlling devices, namely a combustion controlling device controlling the combustion of a combustion furnace, and a safety controlling device checking the operation of the devices wherein the operations are controlled by the combustion controlling device. This enables safer control of combustion because if there is a fault in either the combustion controlling device or the safety controlling device, a process can be performed by

the other device to stop the combustion. Additionally, because the controlling device for controlling the structural elements that control the combustion in the boiler system and the controlling device for operational checks of the outputs from those structural elements are separate, if there is a failure in any of the structural elements or controlling devices, that failure can be detected reliably, enabling safer control of the combustion.

**FIG. 1**



## Description

### Cross Reference to Related Applications

**[0001]** The present application claims priority to Japanese Patent Application No. 2010-079498, filed March 30, 2010, which is incorporated herein by reference.

### Field of Technology

**[0002]** The present invention relates to a combustion controlling device for controlling the combustion of a combustion furnace.

### Background of the Invention

**[0003]** Conventionally, in a combustion controlling device a gas flow path shutoff valve, a gas flow path flow rate controlling damper, an air flow path air supply damper, an air flow rate controlling damper, and the like are controlled based on the gas pressure within the gas flow path, the flow rate of the air within the air flow path, the temperature within the combustion furnace, and the like, in order to control the combustion within the combustion furnace while maintaining a desirable air/fuel ratio (See, for example, Japanese Unexamined Patent Application Publication 2001-235146).

**[0004]** However, conventionally control and monitoring of all of the structural elements have been performed by a single combustion controlling device, and thus there has been the risk that it may become impossible to stop the combustion safely if a fault were to occur within the combustion controlling device itself. Typically control and monitoring has been performed for a plurality of devices by a single combustion controlling device, wherein there has been a relationship such as, for example, between a blower and an air pressure switch for measuring the result of the operation of the blower, that is, a relationship between a controlled device (the blower) and a sensor instrument (the air pressure switch) wherein a measured value is changed by the operation of the controlled device. For convenience, in the below the explanation uses a blower and an air pressure switch as an example. As described above, when a fault occurs in the combustion controlling device in the control system, it becomes impossible to control the blower properly, or impossible to detect the output of the air pressure switch properly, and, as a result, there has been the risk that it may become impossible to stop the combustion.

**[0005]** Given this, the object of the present invention is to provide a combustion controlling device able to control combustion more safely.

### Summary of the Invention

**[0006]** In order to solve the problem set forth above, the combustion controlling device according to the present invention has a first controlling portion for out-

putting, to a first device that controls the combustion in a combustion furnace, a control signal for controlling the operation of the first device; and a second controlling portion for not only checking the operation of the first device, but also for controlling a second device for stopping the combustion; wherein: the first controlling portion outputs a control signal to the second controlling portion; the second controlling portion outputs, to the first controlling portion, an operation check result for the first device; and the first controlling portion and the second controlling portion perform a process to stop the combustion when it is confirmed, based on the control signal and on the operation check result, that there is a fault in the first device.

**[0007]** In the combustion controlling device set forth above, the second controlling portion may stop the combustion through controlling the second device. Moreover, in the combustion controlling device set forth above, the first controlling portion may stop the combustion through controlling the first device.

**[0008]** Given the present example, the provision of two controlling portions, namely a first controlling portion, for outputting, to a first device for controlling the combustion of the combustion furnace, a control signal for controlling the operation of the first device, and a second controlling portion for not only checking the operation of the first device, but also for controlling a second device for stopping the combustion, enables the combustion to be controlled more safely because if a fault were to occur in one of the controlling portions, a process can be performed by the other controlling portion to stop the combustion. Furthermore, because the controlling portion for controlling the first device and the controlling portion for checking the operation of the first device are separate, even if a fault were to occur in either the device or the controlling portion it would still be possible to detect the fault reliably, enabling the control of the combustion to be performed more safely.

### Brief Description of the Drawings

#### [0009]

FIG. 1 is a diagram illustrating schematically a structure for a combustion furnace system according to the present invention.

FIG. 2 is a diagram for explaining an operating sequence if operating properly.

FIG. 3 is a diagram for explaining an operating sequence if a fault has occurred.

FIG. 4 is a diagram for explaining a sequence that illustrates one example from actuation to stopping.

### Detailed Description of the Invention

**[0010]** An example according to the present invention will be explained in detail below in reference to the drawings. Note that in the below the explanation is an example

applied to a boiler system, as a system that uses the combustion controlling device according to the present example.

**[0011]** As illustrated in FIG. 1, the boiler system according to the present example has a combustion device 1 for producing hot water within a tank 11; a fuel flow path 2 for providing fuel to the combustion device 1; an air flow path 3 for providing air from a blower 31 to a main burner 12 of the combustion device 1; a combustion controlling device 4; and a safety controlling device 5.

**[0012]** The combustion device 1 has a tank 11 for storing water; a main burner 12 for heating the tank 11; a pilot burner 13 for igniting the main burner 12; an ignition transformer 14 for igniting the pilot burner 13; a flame detecting device 15 for detecting the ignition status of the main burner 12; a pump 16 for supplying water to the tank 11; and a temperature sensor 17 for detecting the temperature of the water in the tank 11.

**[0013]** The fuel flow path 2 comprises: a main flow path 2a for supplying fuel from the outside, and a first flow path 2b and a second flow path 2c that branch from the main flow path 2a, where the first flow path 2b is connected to the main burner 12 and the second flow path 2c is connected to the pilot burner 13. As a result, the fuel that is supplied to the main flow path 2a is sent to the main burner 12 and the pilot burner 13. Here the main flow path 2a is provided with a gas pressure switch 21, the first flow path 2b is provided with first and second safety shutoff valves 22 and 23, and the second flow path 2c is provided with third and fourth safety shutoff valves 24 and 25.

**[0014]** The air flow path 3 is connected on one end to a blower 31, and connected on the other end to the first flow path 2b, where the air that is expelled by the blower 31 is supplied through the first flow path 2b to be supplied to the main burner 12 together with the fuel. This type of air flow path 3 is provided with an air pressure switch 32 and a damper 33.

**[0015]** The combustion controlling device 4 is structured from an electric circuit such as a programmable logic controller (PLC), and controls structural elements for controlling the combustion in the combustion device 1, such as the pump 16, the blower 31, and the damper 33. This type of combustion controlling device 4 is provided with a communication portion 41 and a combustion controlling portion 42.

**[0016]** Here the communication portion 41 not only inputs the respective detection results from the temperature sensors 17, but also outputs control signals to the pump 16, the blower 31, and the damper 33. Additionally, the communication portion 41 not only outputs the control signals to the safety controlling device 5, but also inputs control signals and detection results, described below, from the safety controlling device 5.

**[0017]** Additionally, the combustion controlling portion 42 controls various types of operations of the boiler system, including the combustion sequence, described below. Specifically, it controls the sequence of various op-

erations of the boiler system, such as starting and stopping the main burner 12 and adjusting the power of the main burner 12, by generating control signals to the blower 31, the damper 33, and the safety controlling device 5, based on the detection results of the temperature sensors 17 and on various types of information from the safety controlling device 5, and the like.

**[0018]** The safety controlling device 5 is structured from electric circuits such as a burner controlling module and an interlock module, and checks the operations of the structural elements controlled by the combustion controlling device 4. Here the interlock module sends, to the burner controlling module, commands such as for starting and stopping the main burner 12 and for adjusting the power of the main burner 12, based on the control signals from the combustion controlling portion 42. The interlock module also ensures safety by checking the status of the combustion, based on signals from the flame detecting device 15, and stopping the fuel supply if there is an irregular event such as incomplete combustion. Additionally, the burner controlling module follows the instructions from the interlock module to ignite the pilot burner 13 and ignite the main burner 12. Moreover, although not illustrated, a plurality of main burners 12 may be provided, and a plurality of burner controlling modules may be provided corresponding thereto, while, additionally, the structure may be one wherein the plurality of burner controlling modules, and the like, is controlled by a single interlock module. This type of safety controlling device 5 comprises a communication portion 51 and a safety checking portion 52.

**[0019]** Here the communication portion 51 not only inputs the detection results from the flame detecting device 15, the gas pressure switch 21, and the air pressure switch 32, along with the control signals from the combustion controlling device 4, but also outputs control signals to the ignition transformer 14 and the first through fourth safety shutoff valves 22 through 25. Moreover, the communication portion 51 not only outputs the control signals and the detection results to the combustion controlling device 4, but also inputs the aforementioned control signals from the combustion controlling device 4.

**[0020]** The safety checking portion 52, based on the detection results from the flame detecting device 15, the gas pressure switch 21, and the air pressure switch 32, and on the control signals generated by the combustion controlling device 4, checks whether or not the various operations can be performed safely by the combustion controlling device 4 that performs one or more steps of the various steps that structure the combustion sequence, described below. If safe performance is confirmed, then the safety checking portion 52 allows the deployment of the various combustion operations, such as causing the process corresponding to the next step to be performed by the combustion controlling device 4. On the other hand, if it is confirmed that there can be no safe operation, the safety checking portion 52 stops the various combustion operations, for example not allowing

the combustion controlling device 4 to advance to the next process.

#### Startup Sequence

**[0021]** The combustion sequence by the combustion controlling device 4 will be explained in reference to FIG. 2 and FIG. 3. In the below, the startup sequence for starting up the boiler system is explained as an example. This startup sequence is structured from a plurality of processes; however, the explanation will be for a case wherein there is a transition from an initial process 1 to the next process 2.

**[0022]** In the case of starting up a boiler system, the following operations are performed as a process 1. First the ignition controlling portion 42 of the combustion controlling device 4 outputs a control signal to the safety controlling device 5 indicating that the boiler system is to be started up.

**[0023]** When the control signal indicating that the boiler system is to be started up is received from the combustion controlling device 4, the safety checking portion 52 of the safety controlling device 5 checks whether or not the signal from the air pressure switch 32 is OFF, and outputs the check result to the combustion controlling device 4.

**[0024]** In this step, the combustion controlling portion 42 does not output a control signal, to the blower 31, requesting driving. Consequently, if the combustion controlling device 4, the safety controlling device 5, the blower 31, and the air pressure switch 32 are all operating properly, then the blower 31 is stopped, and thus no air is supplied into the air flow path 3, and so the air pressure switch 32 that is provided in the air flow path 3 should be in the OFF state. However, if a fault were to occur in the combustion controlling device 4, the safety controlling device 5, the blower 31, or the air pressure switch 32, then the signal from the air pressure switch 32 may turn ON, or the check result may not be outputted to the combustion controlling device 4. For example, as illustrated in FIG. 3, if a fault were to occur in the combustion controlling device 4 so as to output, to the blower 31, a control signal requesting driving, then the signal for the air pressure switch 32 would go ON.

**[0025]** If the signal from the air pressure switch 32 is ON without the control signal indicating the actuation of the boiler system being inputted from the combustion controlling device 4, the safety checking portion 52 determines that a fault has occurred in the combustion controlling device 4, the blower 31, or the air pressure switch 32. Given this, the safety checking portion 52 outputs control signals for stopping the combustion, such as not only preventing the actuation of the ignition transformer 14, but also maintaining the first through fourth safety shutoff valves 22 through 25 in the closed state.

**[0026]** If the checking result of the air pressure switch 32 is not inputted into the combustion controlling device 4, or if a checking result that indicates that the signal from the air pressure switch 32 is ON is inputted, then the

combustion controlling portion 42 determines that a fault has occurred in the safety controlling device 5, and outputs a control signal so as to stop the combustion, such as shutting the damper 33.

**[0027]** This can prevent the hazards in the boiler system, because the combustion operation will not be performed in the boiler system.

**[0028]** On the other hand, if, after the control signal indicating that the boiler system is to be started up is outputted, a check result indicating that the signal for the air pressure switch 32 is OFF is inputted, then the combustion controlling portion 42 would not only output a control signal, to the blower 31, requesting driving, but would also output this control signal to the safety controlling device 5 as well.

**[0029]** When the control signal indicating that the blower 31 is being driven is received from the combustion controlling device 4, the safety checking portion 52 of the safety controlling device 5 checks whether or not the signal from the air pressure switch 32 is ON, and outputs the check result to the combustion controlling device 4.

**[0030]** In this step, if the combustion controlling device 4, the safety controlling device 5, the blower 31, and the air pressure switch 32 are all operating properly, then the blower 31 is driven, and thus air will be supplied into the air flow path 3, and so the air pressure switch 32 that is provided in the air flow path 3 should be in the ON state. However, if there is a fault in any of these structural elements, then the signal from the wind pressure switch may be OFF, or the check result for the air pressure switch 32 may not be inputted into the combustion controlling device 4.

**[0031]** If the signal from the air pressure switch 32 is OFF despite the control signal indicating the driving of the blower 31 being inputted from the combustion controlling device 4, the safety checking portion 52 determines that a fault has occurred in the combustion controlling device 4, the blower 31, or the air pressure switch 32. Given this, the safety checking portion 52 outputs control signals for stopping the combustion, such as not only preventing the actuation of the ignition transformer 14, but also maintaining the first through fourth safety shutoff valves 22 through 25 in the closed state.

**[0032]** If the checking result of the air pressure switch 32 is not inputted into the combustion controlling device 4, or if a checking result that indicates that the signal from the air pressure switch 32 is OFF is inputted, then the combustion controlling portion 42 determines that a fault has occurred in the safety controlling device 5, and outputs a control signal so as to stop the combustion, such as shutting the damper 33.

**[0033]** This can prevent the hazards in the boiler system, because the combustion operation will not be performed in the boiler system.

**[0034]** When it is confirmed that the air pressure switch 32 signal indicates as ON, then the combustion controlling portion 42 of the combustion controlling device 4 advances to the next process 2 in the boiler system startup

sequence.

**[0035]** As explained above, in the present example the provision of two controlling devices, namely the combustion controlling device 4 for controlling the combustion of the combustion furnace and the safety controlling device 5 for not only checking the operation of the device is controlled by the combustion controlling device 4 enables the combustion to be controlled more safely because if a fault were to occur in either the combustion controlling device 4 or the safety controlling device 5, a process can be performed by the other device to stop the combustion. Additionally, because the controlling device for controlling the structural elements that control the combustion in the boiler system (the combustion controlling device 4) and the controlling device for operational checks of the outputs from those structural elements (the safety controlling device 5) are separate, if there is a failure in any of the structural elements or controlling devices, that failure can be detected reliably, enabling safer control of the combustion.

**[0036]** Note that in the present example, a case was explained wherein the occurrence of a fault was confirmed within structural elements having the relationship of a blower 31 and an air pressure switch 32 that checks the output from the blower 31, that for which the check is performed is not limited to the blower 31 and the air pressure switch 32, insofar as it is among structural elements having a relationship of a structural element that performs some sort of operation and a structural element that can confirm an output that derives from the operation of that structural element, and can be set freely as appropriate between the various structural elements that are included in the various sequences, such as checking for the occurrence of a fault in, for example, a damper 33 and a sensor for detecting the position of the damper 33. Given this, with reference to FIG. 4, the entirety of the sequence from startup to shut down in a case wherein the system is operating properly is explained.

**[0037]** As described above, when starting up the boiler system, first the combustion controlling device 4 outputs a control signal to the safety controlling device 5 that the boiler system is to be started up (Step S1). When the control signal for starting up the boiler system is received, the safety controlling device 5 checks the signal from the air pressure switch 32 (Step S2). If it is confirmed that the signal from the air pressure switch 32 is OFF, then the safety controlling device 5 outputs to the combustion controlling device 4 a control signal indicating that the air pressure switch 32 is in the OFF state (Step S3). When the control signal indicating that the air pressure switch 32 is in the OFF state is inputted, the combustion controlling device 4 outputs, to the blower 31, a control signal for causing the blower 31 to be driven (Step S4).

**[0038]** The inputting of the control signal requesting that the blower 31 be driven causes the blower 31 to be driven (Step S5), and when the air pressure switch 32 detects that there is an airflow in the airflow path 3 (Step S6), the safety controlling device 5 outputs, to the com-

bustion controlling device 4, a control signal indicating that there is air flowing in the airflow path 3 (Step S7).

**[0039]** When the control signal indicating that air is flowing in the airflow path 3 is inputted, the combustion controlling device 4 outputs, to the damper 33, a control signal indicating that it is to go to the fully open state (Step S8). Here let us assume that the damper 33 has a low limit switch and a high limit switch.

**[0040]** The damper 33 is in the closed state until inputting the control signal directing the damper 33 to go to the fully open state. Consequently, the low limit switch, which detects whether or not the damper 33 is in the closed state, is in the ON state, that the damper 33 is in the closed state, until the inputting of this control signal 33 (Step S9).

**[0041]** When the control signal instructing the fully open state is inputted, the damper 33 puts the damper to the fully open state (Step S10). As a result, the high limit switch, which detects whether or not the damper 33 is in the fully open state, goes to the ON state, that the damper 33 is in the fully open state (Step S11). At this time, the low limit switch goes to the OFF state because the damper 33 is in the fully open state.

**[0042]** When the damper 33 being in the fully open state is confirmed (Step S12), the safety controlling device 5, in order to maintain the pre-purge, maintains, for a specific amount of time (the pre-purge time) the driving of the blower 31 and the fully open state of the damper 33 (Step S13). Once this specific amount of time has elapsed, then the safety controlling device 5 outputs, to the combustion controlling device 4, a control signal indicating that the specific amount of time has elapsed (Step S14).

**[0043]** When the control signal indicating that the specific amount of time has elapsed has been inputted, the combustion controlling device 4 outputs, to the damper 33, a control signal indicating that the damper 33 is to be closed (Step S15).

**[0044]** When the control signal instructing the closed state is received, the damper 33 puts the damper into the closed state. When the damper 33 goes to the closed state, the high limit switch goes into the OFF state and the low limit switch goes into the ON state (Step S16). When the low limit switch is confirmed to be in the ON state (Step S17), the safety controlling device 5 outputs control signals to open the third and fourth safety shutoff valves 24 and 25 (Step S18) and outputs a control signal to start up the ignition transformer 14 (Step S19).

**[0045]** The third and fourth safety shutoff valves 24 and 25 go to the open state (Step S20), and when it is confirmed, by the gas pressure switch 21, that gas is flowing in the fuel flow path 2 (Step S21) and confirmed by the flame detecting device 15 that the pilot burner 13 has been ignited (Step S22), the safety controlling device 5 outputs a control signal to stop the ignition transformer 14 (Step S23). When this control signal is inputted, the ignition transformer 14 stops its operation.

**[0046]** Additionally, when the control signal indicating

that the pilot burner 13 has ignited is inputted from the safety controlling device 5 (Step S24), the combustion controlling device 4 outputs, to the safety controlling device 5, a control signal indicating that the main burner 12 is to be ignited (Step S25). When this is done, the safety controlling device 5 outputs control signals to place the first and second safety shutoff valves 22 and 23 into the open state (Step S26). When the first and second safety shutoff valves 22 and 23 go to the open state (Step S27) and the ignition of the main burner 12 is confirmed by the flame detecting device 15, then the safety controlling device 5 outputs a control signal indicating that the third and fourth safety shutoff valves 24 and 25 are to be put into the closed state (Step S28), to close the third and fourth safety shutoff valves 24 and 25. The boiler system is started up through these processes. In stopping the boiler system from the state wherein the boiler system has been started up in this way, when a control signal indicating that the boiler system is to be shut down is received from the combustion controlling device 4 (Step S30), the safety controlling device 5 outputs a control signal indicating that the first and second safety shutoff valves 22 and 23 are to be closed (Step S31), to place the first and second safety shutoff valves 22 and 23 into the closed state. When it is confirmed by the gas pressure switch 21 that there is no flow of gas in the fuel flow path 2 (Step S21) and confirmed by the flame detecting device 15 that there is no flame in the main burner 12, the safety controlling device 5 then stops operating.

**[0047]** In the sequence from startup to shutdown in this way, it is possible to check for the occurrence of faults among the low limit switch and the high limit switch and the damper 33, among the ignition transformer 14 and the flame detecting device 15, among the first through fourth safety shutoff valves 22 and 25 and the gas pressure switches, and the like, to check for faults between structural elements wherein there is a relationship between structural elements that perform some type of operation and structural elements that check an output that is derived from the operation of those structural elements.

**[0048]** The present invention can be applied to combustion controlling devices for controlling combustion in combustion furnaces that are used in boiler systems, and the like.

## Claims

### 1. A combustion controlling device comprising:

a first controller outputting, to a first device controlling the combustion in a combustion furnace, a control signal controlling the operation of the first device; and  
a second controller checking the operation of the first device, and controlling a second device that stops the combustion;  
wherein the first controller outputs a control sig-

nal to the second control;

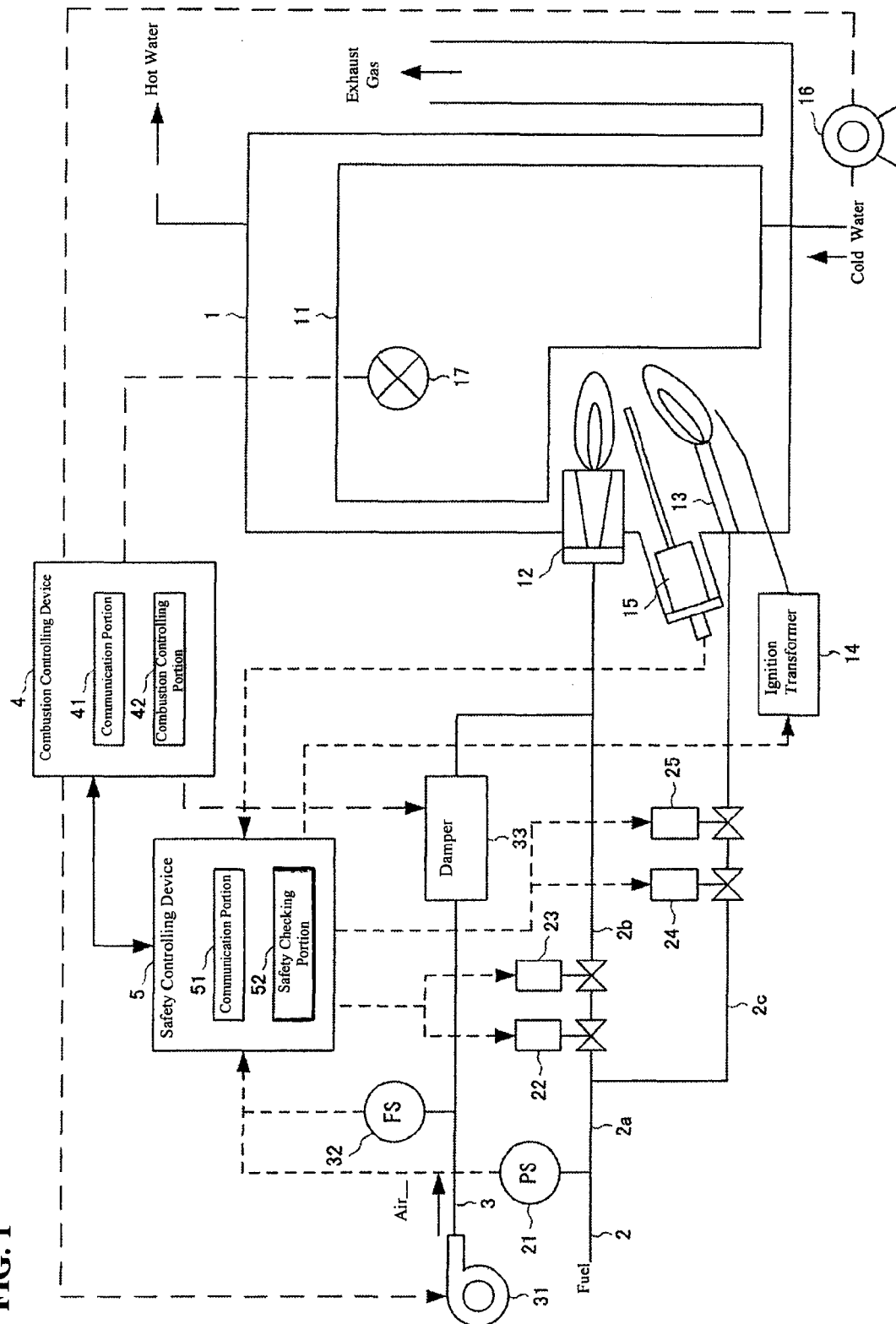
wherein the second controller outputs, to the first controller, an operation check result for the first device; and

wherein the first controller and the second controller perform a process to stop the combustion when it is confirmed, based on the control signal and on the operation check result, that there is a fault in the first device.

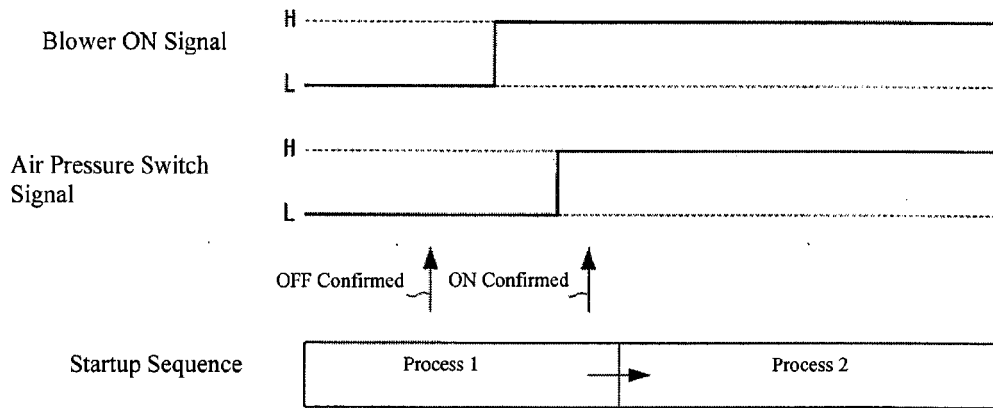
2. A combustion controlling device as set forth in Claim 1, wherein the second controller stops the combustion by controlling the second device.

3. A combustion controlling device as set forth in Claim 1, wherein the first controller stops the combustion by controlling the first device.

FIG. 1



**FIG. 2**



**FIG. 3**

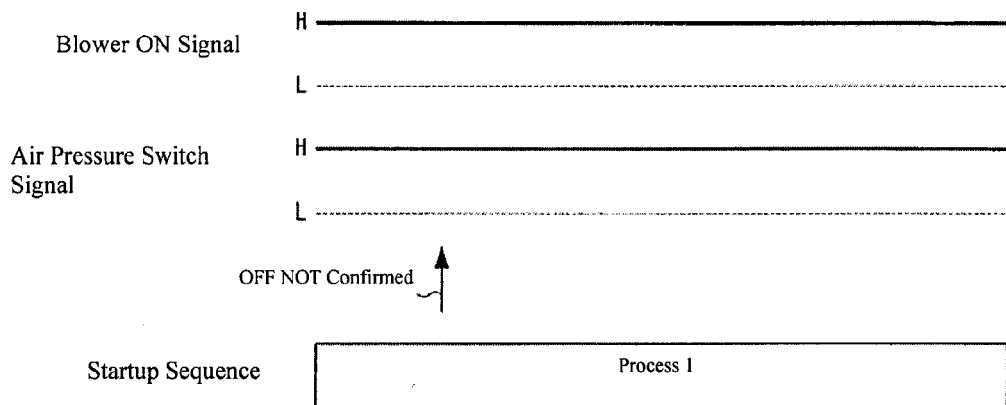
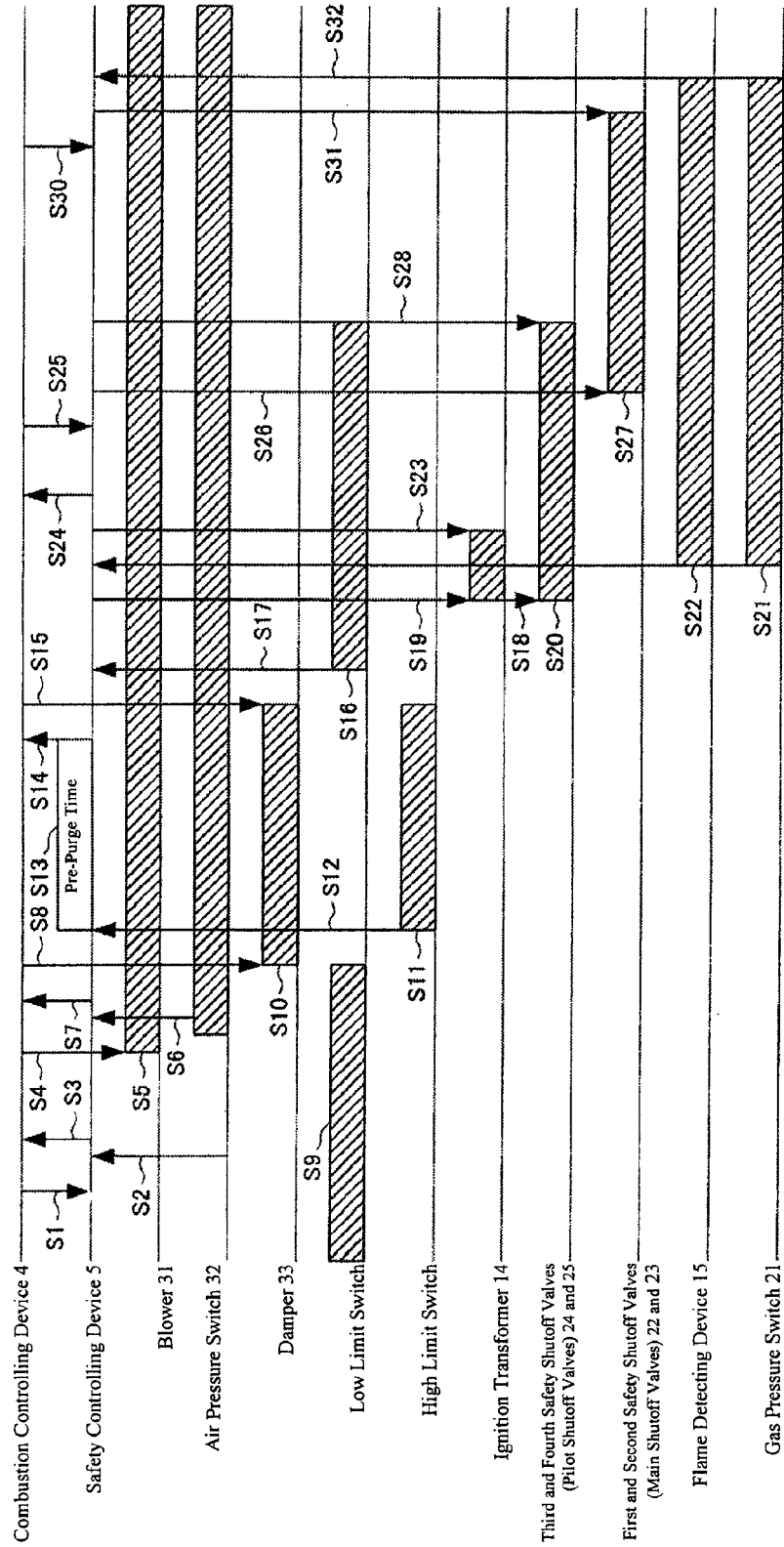




FIG. 4



**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2010079498 A [0001]
- JP 2001235146 A [0003]