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Smith et al.(10) **Pub. No.: US 2015/0300640 A1**(43) **Pub. Date: Oct. 22, 2015**(54) **MINIMUM INPUT AIR PROVIDING DEVICE
AND METHOD**(52) **U.S. Cl.**CPC *F23N 3/002* (2013.01); *F23N 3/082*
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(57)

ABSTRACT(73) Assignee: **The Marley-Wylain Company,**
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An airflow proving device is provided. The device includes: a housing defining an airflow pathway; a first chamber within the housing; a second chamber within the housing located downstream in the flow pathway from the first chamber; structure in the housing defining an orifice, the orifice providing fluid communication between the first and second chamber and being part of the fluid pathway; and a pressure measuring device having a first sensor configured to monitor a pressure in the first chamber and a second sensor configured to monitor a pressure in the second chamber.

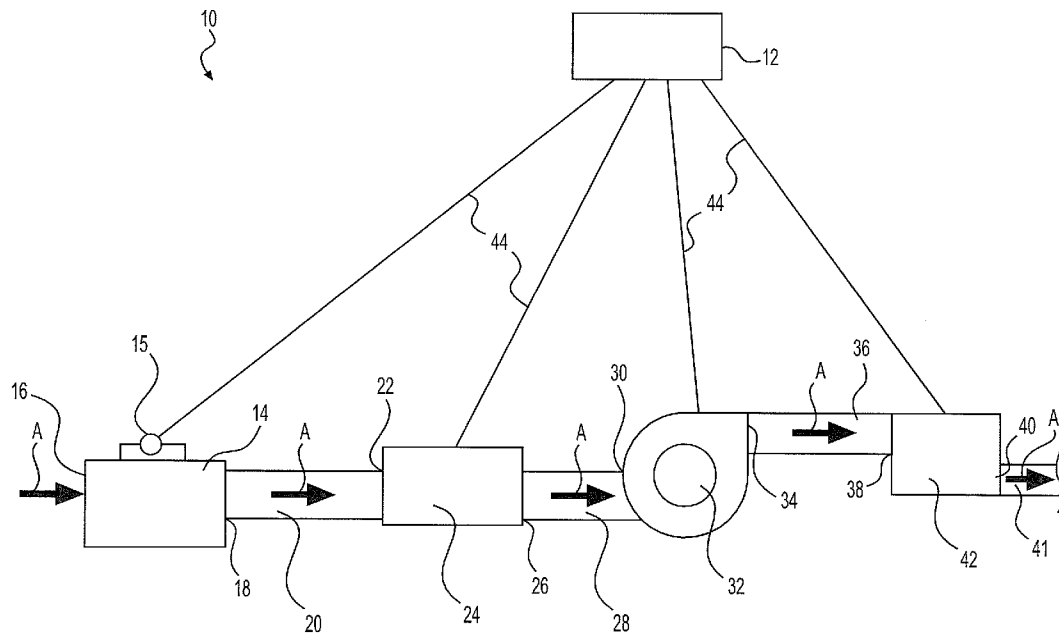


FIG. 1

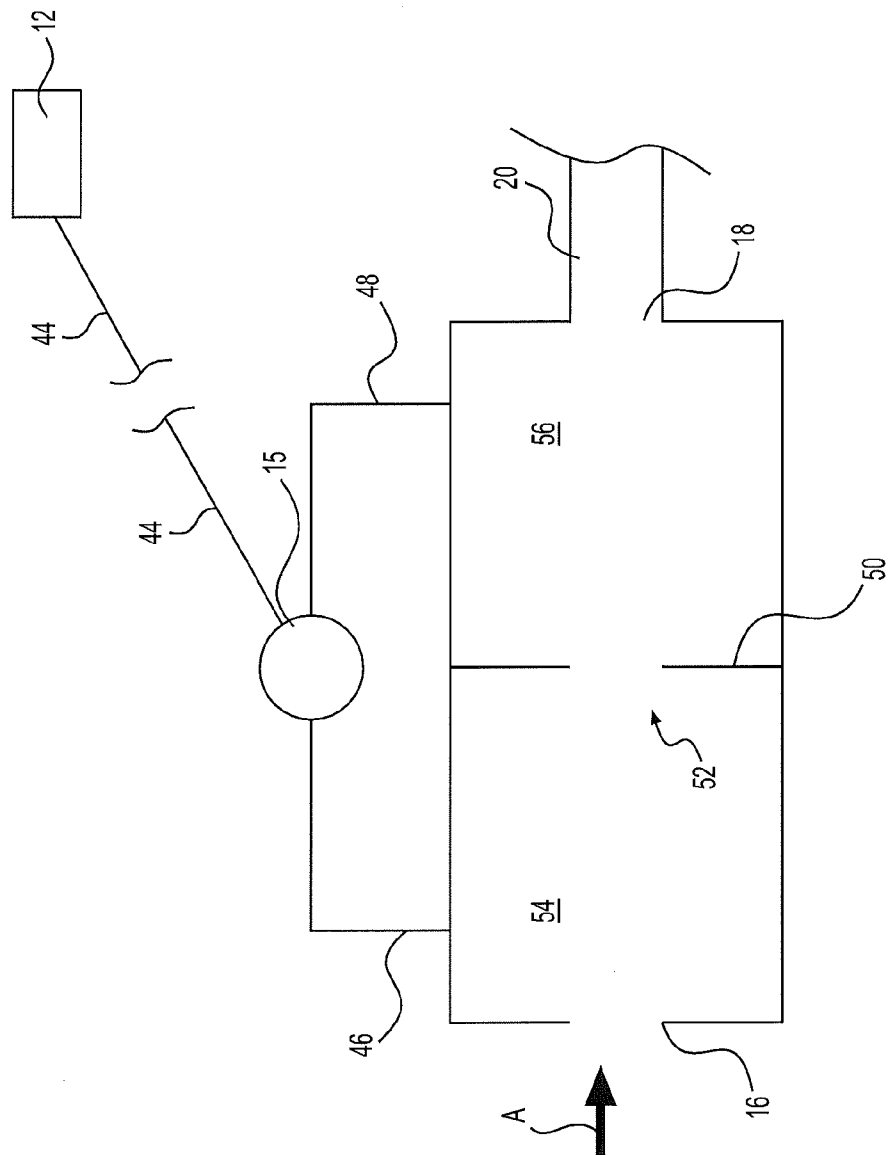
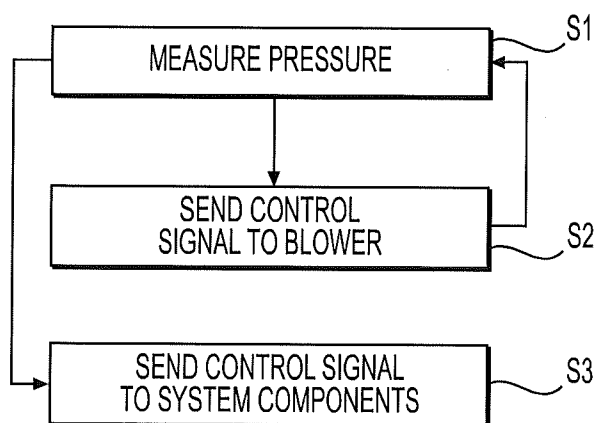


FIG. 2

**FIG. 3**

MINIMUM INPUT AIR PROVIDING DEVICE AND METHOD

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates generally to an apparatus and method for confirming airflow through a pathway. More particularly, the present invention relates to an apparatus and method for confirming airflow through a system that includes a combustion device.

BACKGROUND OF THE INVENTION

[0002] Combustion systems such as boilers, furnaces or any other commercial or household combustion system rely on air flowing through the system to assure proper combustion at the burner. Good and reliable flow of air through the system aids to provide complete combustion of the fuel. Manufacturers of equipment which utilize combustion as an energy source are continuing to increase the turndown ratio of that equipment. The turndown ratio is the ratio of the minimum and maximum input rate of a particular unit. What may be input may be air, fuel, or a combination of an air-fuel mixture.

[0003] As the minimum input rate decreases, the ability to accurately control the combustion process may become increasingly difficult. When certain conditions present themselves, for example, blocked combustion air, blocked exhaust pipes, or wind conditions at the vent termination unit may cause the combustion process to lose stability or efficiency. This loss in combustion may create incomplete combustion which can create large amounts of carbon monoxide or even loss of flame. These and other undesirable conditions may be the result of a lack of airflow through the combustion system. As a result, it can be difficult to ensure that at least a minimal amount of air is, in fact, flowing through the combustion system.

[0004] Relying on a setting for a blower to provide accurate information regarding flow of air through the system may be problematic. Blowers will tend to run and perhaps even increase in speed when there are blockages of airflow through the system. As a result, while the blower speed may provide a good approximation of airflow during ideal conditions, blower speed does not always provide a reliable indication of airflow during adverse conditions such as, for example, but not limited to, blockages in the airflow path or wind conditions at the vent termination unit. As a result, reliance on the blower speed alone does not confirm an amount of air flowing through the system.

[0005] Accordingly, it is desirable to provide a method and apparatus that may provide a more reliable indication of air flowing through the system and specifically, confirmation of a minimum of input air flowing through the system.

SUMMARY OF THE INVENTION

[0006] The foregoing needs are met, to a great extent, by the present invention, wherein in one aspect an apparatus is provided that in some embodiments a method and apparatus may provide a more reliable indication of air flowing through the system and specifically, confirmation of a minimum of input air flowing through the system.

[0007] In accordance with one embodiment of the present invention, an airflow proving device is provided. The device includes: a housing defining an airflow pathway; a first chamber within the housing; a second chamber within the housing

located downstream in the flow pathway from the first chamber; structure in the housing defining an orifice, the orifice providing fluid communication between the first and second chamber and being part of the fluid pathway; and a pressure measuring device having a first sensor configured to monitor a pressure in the first chamber and a second sensor configured to monitor a pressure in the second chamber.

[0008] In accordance with another embodiment of the present invention, a method for confirming airflow is provided. The method includes: configuring air to flow between a first chamber and a second chamber through an orifice; measuring an air pressure associated with the first chamber; measuring an air pressure associated with the second chamber; comparing the two measured pressures against a threshold; and adjusting a speed associated with the blower depending upon the difference between the air pressure associated with the first chamber and the air pressure associated with the second chamber falls below the threshold.

[0009] In accordance with yet another embodiment of the present invention, an airflow proving device is provided. The device may include: means for defining an airflow pathway; a first chamber within the housing; a second chamber within the housing located downstream in the flow pathway from the first chamber; means for defining an orifice, the orifice providing fluid communication between the first and second chamber and being part of the fluid pathway; and means for comparing measuring pressure having a first means for sensing a pressure in the first chamber, and a second means for sensing pressure associated with the second chamber.

[0010] There has thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

[0011] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

[0012] As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a schematic diagram of a combustion system incorporating a minimum input air proving device in accordance with the disclosure.

[0014] FIG. 2 is a schematic, cross-sectional view of a minimum input air proving device in accordance with the disclosure.

[0015] FIG. 3 is a flowchart outlining steps for accomplishing a method of controlling a combustion system that includes confirming an amount of air flowing through the system in accordance with the disclosure.

DETAILED DESCRIPTION

[0016] The invention will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout. An embodiment in accordance with the present disclosure provides a method and apparatus for determining or verifying that there is at least a minimal air-flow through the system.

[0017] A combustion system 10 is shown in FIG. 1. The combustion system 10 includes a controller 12 operably connected to various components in the system 10. An airflow proving device 14 in accordance with this disclosure is mounted in an initial portion of an air pathway. The air flow proving device 14 includes a pressure measuring device 15. The airflow proving device 14 has an air inlet 16 and an air outlet 18. Airflow is represented by arrows A through the system 10. Air flows through the air inlet 16 through the airflow proving device 14 and out the air outlet 18. The air pathway continues through the airflow proving device 14 through a conduit 20 into the inlet 22 of an air/fuel mixture device 24. In the air/fuel mixture device 24, fuel is combined with the air flowing through the airflow pathway. In some embodiments, the air and fuel mixing may occur via a venturi-type system. In other embodiments other ways of mixing the air and fuel together may occur in accordance with this disclosure.

[0018] After the air and fuel have mixed in the air/fuel mixture device 24, the air/fuel mixture will flow through the outlet 26 through the conduit 28 into the inlet 30 of the blower 32. The blower 32 moves the air and/or air/fuel mixture through the system 10. The after the air/fuel mixture flows to the blower 32 it flows out of the outlet 34 into the conduit 36 and into the inlet 38 of the combustion device 42. Once the air/fuel mixture is in the combustion device 42, it will combust as controlled by the combustion device 42. After combustion, the exhaust gases will flow out of the outlet 40 and through the exhaust system 41.

[0019] In some embodiments, the combustion device 42 may be a furnace, a boiler, heater, or any other combustion device. While the examples set forth herein primarily discuss combustion used in domestic or commercial heat this disclosure may also be applicable to any type of combustion device.

[0020] FIG. 2 is a close-up cutaway view of an air flow proving device in accordance with an embodiment. The air-flow proving device 14 includes a wall 50 that defines an orifice 52. The orifice 52 provides fluid communication between the inlet chamber 54 and the outlet chamber 56. Air, as represented by arrow A, flows into the inlet 16 and into the inlet chamber 54. The air continues to flow through the orifice 52 into the outlet chamber 56 out of the outlet 18 and into the conduit 20 and continues along the fluid pathway as illustrated and described with respect to FIG. 1.

[0021] The pressure measuring device 15 has two leads 46 and 48. The lead 46 is configured to sense a pressure associated with the air in the inlet chamber 54. The lead 48 is configured to sense an air pressure associated with the outlet chamber 56. In embodiments where the pressure measuring device 15 is simply a pressure switch, if a difference between the pressure sensed by leads 46 and 48 goes below a minimum threshold, then the pressure measuring device 15 will send a

signal via connection 44 to the controller 12. In this case, the pressure measuring device 15 acts like a pressure switch and trips if a minimum threshold is exceeded.

[0022] In other embodiments, the pressure measuring device 15 acts as a pressure sensor and sends signals to the controller 12 via the connection 44 indicative of a difference in pressure detected by leads 46 and 48.

[0023] In some embodiments, if the orifice 52 is sized appropriately with respect to a desired airflow, as air flows through the airflow proving device 14 as represented by arrow A, the airflow will encounter a bottleneck at orifice 52. This will cause pressure to decrease within chamber 56 in comparison to chamber 54. If a lot of air is moving through the airflow proving device 14, then there will be a large pressure difference between chambers 54 and 56. This pressure difference will be a result of a vacuum in chamber 56 as a result of the bottleneck of air trying to flow through the orifice 52. If no or little air is flowing through the airflow proving device 14 then the pressures between chambers 54 and 56, as sensed or detected by the pressure measuring the device 15, will approach or equal a zero difference in pressure. As a result, the higher difference in pressure detected by leads 46 and 48 will indicate higher airflow through the airflow proving device 14. Thus, the pressure measuring device 15 can confirm by measuring different pressures within chambers 54 and 56, whether air is flowing through the air proving device 14.

[0024] Returning to FIG. 1, in some embodiments, the controller 12 is connected via connections 44 to the pressure measuring device 15, the air/fuel mixture device 24, the blower 32, and the combustion device 42. In other embodiments, the controller 12 may be connected only to the pressure measuring device 15 and the blower 32. In other embodiments the controller 12 may be connected to the pressure measuring device 15, the blower 32, and any other combination of elements within the system 10.

[0025] In some embodiments, the signals received by the controller 12 from the pressure measuring device 15 will allow the controller 12 to determine whether to speed up, slow down, maintain speed, or turn off the blower 32. In other embodiments, feedback or signals received by the controller 12 from the pressure measuring device 15 may result in the controller 12 generating other control signals to other components of the system 10. For example, depending on signals received by the controller 12 from the pressure measuring device 15, the controller 12 may give control signals to the air/fuel mixture device 24, the blower 32, the combustion device 42, or any combination of those elements.

[0026] In some embodiments, the minimum threshold settings may be programmed by a user or set at the factory. These settings may remain fixed until the controller 12 is reprogrammed. In some embodiments, control settings or present conditions at various components such as the air/fuel mixture device 24, the blower 32, or the combustion device 42, may result in the controller reacting differently to signals received from the pressure measuring device 15. For example, if the blower 32 is set at a relatively slow speed causing air and/or air/fuel mixture to flow through the system 10 at a relatively slow pace, then the controller 12 will allow the blower 32 to operate without further signals from the controller to change operation of the blower 32 when signals from the pressure measuring device 15 indicate a relatively low airflow in the airflow proving device 14. Thus, the threshold that the controller 12 uses to make decisions on whether to interfere with

operation of other components within the system 10 may depend upon the current setting of those components. As a result, if, for example, the blower 32 is operating at a relatively high speed, then the controller 12 will demand a relatively high amount of air flow through the airflow proving device 14 as detected by the pressure monitoring device 15, but if the blower 32 is operating at a relatively low speed, then the controller 12 will lower the threshold of detective air flowing through the air proving device 14 before interfering with operation blower 32 or any of the other components in the system 10. One of ordinary skill in the art, after reviewing this disclosure, will understand what thresholds to program into the controller to achieve desired system performance.

[0027] FIG. 3 illustrates an example method that may be accomplished by the system 10. For example in step S1, the system 10 measures pressure. This can be accomplished by the pressure measuring device 15 sensing a difference in pressure within the chambers 54 and 56. In step S2, the controller 12 may send a control signal to the blower 32. This control signal may, in some embodiments, be to shut down the blower 32. In other embodiments, this control signal may be to speed up or slow down the blower 32. In an optional step S3, depending upon the measured pressure done at step S1, the controller 12 may send a control signal to other system components such as the combustion device 42 and/or the air/fuel mixture device 24.

[0028] In embodiments where the pressure measuring device 15 is a pressure switch, if there is little or no difference (the difference falls below a minimal threshold) the pressure switch 15 may send a signal to the controller 12 indicating such. The controller 12 will then detect that the airflow through the system 10 is below a minimum threshold and then shut down the blower 32 and or combustion device 42. In some embodiments, the controller 12 may also shut down other components such as the air/fuel mixture device 24. In some embodiments where the pressure measuring device 15 is a pressure switch 15 and the difference in pressure detected in chambers 54 and 56 falls below a minimum threshold, the controller 12 may increase the speed of the blower 32 and wait a preset amount of time to see if there is a pressure increase in chamber 54 with respect to chamber 56. If the difference in pressure between chambers 54 and 56 still remain below the minimum threshold after the set amount of time, the controller 12 may then shut down any, all, or some of the other components in the system 10 such as, but not limited to, the blower 32, the combustion device 42, and the air/fuel mixture device 24.

[0029] In embodiments where the pressure measuring device 15 is a pressure sensor, then the controller 12 may have different minimum threshold differences in pressure between the chambers 54 and 56 depending upon the speed of the blower 32. If the detected difference in pressure falls below a minimum threshold for a given speed, the controller 12 may shut down one, all, or some of the components of the system such as, but not limited to, the blower 32, the combustion device 42, or the air/fuel mixture device 24. In other embodiments, when the pressure difference between the chambers 54 and 56 fall below a minimum threshold for a given blower speed, the controller 12 may increase the blower speed and await a set amount of time and re-measure the difference in pressures between the chambers 54 and 56. If the pressure differential is still below minimum threshold, then the controller 12 may shut down any, all, or portions of the system

such as, but not limited to, the blower 32, the combustion device 42, and/or the air/fuel mixture device 24.

[0030] In some embodiments, when the detected pressure differential between the chambers 54 and 56 falls below a minimum threshold, the controller 12 may also set off an alarm indicator in addition to shutting down various components of the system 10.

[0031] After reviewing this disclosure, one of ordinary skill in the art will understand what minimum thresholds should be for a given system 10. The system operator will also understand what time periods are appropriate, if any, for measuring the pressure differential between chambers 54 and 56 after a first control signal has been sent. One of ordinary skill in the art, after viewing this disclosure, will also understand what size the orifice 52 should be for a specific system 10. Other dimensions and settings will also be understood.

[0032] Although an example of the system is shown and described, for home or commercial heating systems, it will be appreciated that other combustion systems can use features discussed herein.

[0033] The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described. Accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. An airflow proving device comprising:
 - a housing defining an airflow pathway;
 - a first chamber within the housing;
 - a second chamber within the housing located downstream in the flow pathway from the first chamber;
 - structure in the housing defining an orifice, the orifice providing fluid communication between the first and second chamber and being part of the fluid pathway; and
 - a pressure measuring device having a first sensor configured to monitor a pressure in the first chamber and a second sensor configured to monitor a pressure in the second chamber.
2. The airflow proving device of claim 1, wherein the pressure measuring device is a pressure switch.
3. The airflow proving device of claim 2, further comprising a controller operatively connected to the pressure measuring device and operatively connected with a blower fluidly connected to the airflow pathway.
4. The airflow proving device of claim 3, wherein the controller is configured to turn off the blower if the pressure switch is tripped.
5. The airflow proving device of claim 1, further comprising a system to which the airflow proving device is part of the system further comprising:
 - a controller operatively connected to the pressure measuring device;
 - a fuel mixing device configured to add fuel to air in the airflow;
 - a blower configured to move the air and fuel along the airflow pathway; and
 - a combustion device configured to receive the air/fuel mixture from the airflow pathway and burn the fuel in the air.

6. The airflow proving device of claim 5, wherein the fuel mixing device is operatively connected to the controller and the controller is configured to adjust an air/fuel mixture in the airflow.

7. The airflow proving device of claim 5, wherein the controller is operatively connected to the blower and is configured to turn on and off the blower.

8. The airflow proving device of claim 5, wherein the controller is operatively connected to the blower and is configured to adjust a speed associated with the blower.

9. The airflow proving device of claim 5, wherein the controller is operatively connected to the combustion device and is configured to control combustion occurring within the combustion device.

10. The airflow proving device of claim 1, wherein the pressure measuring device is a pressure transducer.

11. The airflow proving device of claim 10, further comprising a controller operatively connected to the pressure measuring device and operatively connected with a blower fluidly connected to the airflow pathway and the controller is configured to adjust a speed associated with the blower.

12. The airflow proving device of claim 1, further comprising a controller operatively connected to the pressure measuring device and the blower wherein the controller is configured to adjust the speed associated with the blower if a difference in pressure measured by the first sensor and second sensor falls below a threshold.

13. The airflow proving device of claim 12, wherein the controller will adjust the speed associated with the blower to be faster if a difference in pressure measured by the first sensor and the second sensor falls below a first threshold.

14. The air proving device of claim 13, further comprising additional thresholds after the first threshold, wherein the controller is configured to increase a speed associated with the blower after the difference in pressure measured by the first sensor and second sensor falls below each of the thresholds.

15. The air proving device of claim 14, further comprising a final threshold and the controller is configured to shut down the blower if the pressure measured by the first and second sensors falls below the final threshold.

16. The air proving device of claim 12, wherein the controller will turn off the blower if a difference in pressure measured by the first sensor and second sensor falls below the threshold.

17. The airflow proving device of claim 12, wherein the controller includes a timing device and the controller is further configured to increase a speed associated with the blower when the difference in pressure measured between the first sensor and the second sensor falls below a threshold and if the difference in pressure measured between the first sensor and the second sensor does not increase past a second threshold after a set amount of time after the speed associated with the blower has increased, then the controller will turn off the blower.

18. The airflow proving device of claim 12, wherein the threshold is different depending upon the current speed associated with the blower.

19. A method for confirming airflow comprising:
configuring air to flow between a first chamber and a second chamber through an orifice;
measuring an air pressure associated with the first chamber;
measuring an air pressure associated with the second chamber;
comparing the two measured pressures against a threshold;
and
adjusting a speed associated with the blower depending upon the difference between the air pressure associated with the first chamber and the air pressure associated with the second chamber falls below the threshold.

20. An airflow proving device comprising:
means for defining an airflow pathway;
a first chamber within the housing;
a second chamber within the housing located downstream in the flow pathway from the first chamber;
means for defining an orifice, the orifice providing fluid communication between the first and second chamber and being part of the fluid pathway; and
means for comparing measuring pressure having a first means for sensing a pressure in the first chamber, and a second means for sensing pressure associated with the second chamber.

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