APPARATUS FOR AND METHOD OF OPERATING A FURNACE BLOWER TO EVAPORATE CONDENSATE WITHIN AN EXHAUST FLUE

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ABSTRACT
A blower for a furnace is provided where the blower has an impeller that is configured to create a primary air flow of combustion air into the blower housing and a secondary air flow of cooling air through the blower motor. The primary air flow of combustion air into the furnace generates hot exhaust gases for a heat exchanger in the furnace. The secondary air flow cools the blower motor. The secondary air flow is mixed with the hot exhaust gases in the blower housing and cools the exhaust gases before being discharged from the blower housing. A control operates the blower for a time period after each combustion cycle to introduce ambient air into the exhaust flue and chimney to ensure the evaporation of any condensate forming from the products of combustion contained in the exhaust. The blower may be a variable or multi-speed motor so that a different motor speed may be used for combustion than for the run time after combustion.
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CROSS REFERENCE TO RELATED APPLICATION

BACKGROUND OF THE INVENTION
[0002] 1. Field of the Invention
[0003] This invention relates generally to a draft inducing blower in a furnace, and, more particularly, the invention pertains to an improvement in the blower design that provides not only for internal cooling for a motor that drives the blower but also a control that runs the blower motor for a period of time after a combustion cycle to ensure that any condensate that collects in the exhaust flue including the chimney will evaporate.
[0004] 2. Description of the related Art
[0005] Blowers to which the present invention is directed are common in the art. Generally, these blowers are located downstream of a combustion chamber or combustion tubes in the furnace, depending upon the style of furnace. The blower induces combustion air to be drawn into the combustion chamber or combustion tubes, where the combustion air is mixed with fuel and ignited to generate heat for the furnace. The heated exhaust gases are then drawn through a heat exchanger by the blower and discharged from the blower to an exhaust pipe or flue that vents to the outside atmosphere typically through a chimney. This chimney may be a masonry chimney with a clay tile liner, as is well known in the art.
[0006] The blower generally includes a blower housing and a blower motor installed on the blower housing. The blower housing typically has a side wall, top piece, and bottom piece that define a volute for the blower housing. When the blower is energized, an impeller, operably connected to a shaft of the blower motor, rotates in the volute to draw exhaust gases through an intake hole in the center of the bottom piece and to compress gases in the volute. The impeller draws exhaust gases directly from the combustion chamber or combustion tubes into the blower housing. The pressurized exhaust gases are directed into a discharge exit that extends outward and away from the side wall of the blower housing. In this arrangement, the impeller rotates at a high rate of speed to generate sufficient air flow to draw combustion air into the combustion chamber and combustion tubes and to expel the exhaust gases into the exhaust flue. The discharge exit is coupled to an exhaust pipe or flue that vents the exhaust gases to atmosphere through a chimney. This exhaust flue is totally dependent on the installation, but is subject to certain limitations imposed by various building codes such as the National Fuel Gas Code and in accordance with the safety standards set by various industry groups.
[0007] In a typical conventional furnace, the combustion air is drawn into a vestibule of the furnace before it is directed into the combustion chamber or combustion tubes. Generally, the blower motor and blower housing are located in the vestibule with the blower intake in communication with the combustion chamber or combustion tubes. Control electronics for the furnace are also generally located in the vestibule or blower compartment.

[0008] During operation of the furnace, temperatures in the vestibule increase and tend to degrade performance of furnace components located in the vestibule. The proximity of the vestibule to the combustion chamber or tubes and the heat generated by the blower motor as the motor runs elevate the temperature within the vestibule. The hot exhaust gases circulating through the blower also contribute to the elevated temperatures in the vestibule. The elevated temperature within the vestibule tends to shorten the life of the blower motor, and electronics and controls located within the vestibule. However, because the blower draws relatively cool air into the vestibule before combustion, the vestibule is generally the preferred place on the conventional furnace for positioning temperature sensitive equipment for the furnace. Additionally, to maintain proper operation of the blower motor during the period of elevated temperature in the vestibule, conventional blower motors utilize an auxiliary fan attached to the rotating shaft of the motor to dissipate the heat generated by the motor.

[0009] Although the auxiliary fan usually provides adequate heat removal for the motor, the auxiliary fan has many disadvantages. First, the use of an auxiliary fan on the blower motor increases the size and/or height of the motor assembly, thereby preventing the streamlining of the motor assembly and reduction of the space reserved for the blower in the furnace. Because the auxiliary fan is generally positioned outside of the motor casing, guards and other safety devices must be attached to the motor casing to prevent inadvertent contact with the rotating fan blades during operation. The guard and the fan itself also add cost to the blower motor. The blower motor with an auxiliary fan generates additional noise. Finally, because the motor is positioned in the vestibule, the auxiliary fan re-circulates and reuses air in the vestibule. This re-circulation and reuse of the air in the vestibule contributes to the elevated temperatures of the vestibule and the associated components positioned therein. Because the motor operates in the vestibule at higher temperatures, the motor capacity must again be increased, which adds cost to the blower.

[0010] Historically, gas fired furnaces came first in which no combustion blower was provided and instead the natural convection forces were relied on to exhaust the products of combustion from the combustion chamber and heat exchanger. In these kind of installations, measurements were made and standards were set for the sizing and placement of flue vents to ensure that condensate which had a tendency to form on the inside of chimneys was allowed to evaporate to avoid damaging the chimney liner typically made of clay tile. About twenty years or so ago, combustion blowers were first implemented as they were found to increase the efficiency of furnaces in converting fuel into usable heat. While this improvement was highly desirable from an efficiency standpoint, it created new problems with respect to determining and implementing the proper size of flue pipes needed to ensure that the chimney remained dry as the furnace operated. These issues were worked out with the solutions being that, in general, smaller diameter chimneys or vents were required to accommodate the exhaust from a furnace of the same capacity having a combustion blower than a simple draft furnace.
[0011] As a partial solution to this problem, which was particularly acute for replacement of old design draft type furnaces not having draft induced motors with draft induced furnaces which might otherwise require expensive adjustment of flue pipe sizes or furnace placement, what are called chimney kits were developed. Examples of a chimney kit may be found in U.S. Pat. Nos. 6,112,741; 5,941,230; and Des. 386,577; the disclosures of which are incorporated herein by reference. Basically, these chimney kits comprise draft hoods that, through convection, introduce ambient air into the exhaust flue which helps to lower the dew point temperature in the flue which thereby increases the tendency for condensate to form in the chimney after which it can be evaporated. Regulating the air flow through the chimney kit allows the room temperature air to flow through the kit. This allows a natural draft to occur as in the older style furnaces. While a chimney kit does provide a solution enabling replacement of an older design draft furnace with an updated furnace having a combustion blower with minimal reconfiguration of the flue pipes, it does have several drawbacks including its expense and installation cost.

[0012] Draft hoods have also found use in other fuel fired appliances such as gas hot water heaters. However, these installations have to deal with the same “wet” chimney concerns, and retrofit installations, or replacement installations, must also find a way to prevent a wet chimney. This is true for any Category I or II fuel burning appliance as defined by the appropriate standards agency, and includes various types of appliances including water heaters, furnaces, etc. fueled by various types of fuel including oil, gas, wood, etc. A report and paper was prepared in August of 1992 by Battelle for the Gas Research Institute entitled “Analysis of the Effects of Dilution Air and Appliance Efficiency on Venting Category I Gas Appliances”, the disclosure of which is incorporated herein, which investigated the impact of dilution air and appliance efficiency on the design and installation guidelines for venting Category I gas appliances. The investigation utilized a computer program named “VENT II” for simulating appliance operation given a specified set of installation parameters to help determine whether a chimney of a prescribed size would reach a steady state “dry” condition within an allowed period of operation with a draft hood. Several conclusions drawn in the study are important for consideration here. It was concluded that a draft hood did not appear to offer any advantages on an appliance with a steady state efficiency greater than 80.5 percent in terms of the venting requirements, but “may” offer significant advantages for appliances operating at 80.5 percent efficiency and below. Indeed it was concluded “At 83 percent steady-state efficiency, no method of adding dilution air to the vent configuration examined (20-ft. height, 5-ft. single-wall lateral, 4-inch diameter) allowed the chimney to dry out within the wettime limit.” These conclusions were summarized in Table 4 in the report which indicated that even under the operational conditions of the several modalities tried, an appliance operating at 83 percent efficiency always resulted in a wet chimney. These various operating modalities included a) no dilution air introduced into the flue; b) use of a draft hood to introduce dilution air; c) use of a draft hood and a flue damper which allowed dilution air to enter the vent system only during the on-cycle; d) a small hole in the blower housing through which dilution air could pass continuously; and e) continuous operation of the combustion blower. For an appliance operating at 80.5 percent efficiency only the draft hood modality achieved a dry chimney. Thus, based on this authoritative report, a draft hood was taught as the modality of choice in order to achieve a dry chimney, over the other modalities tested including running the blower full time.

[0013] It is also known in the prior art that it is desired to operate the combustion blower for perhaps a pre-purge time and a post-purge time, to clear the combustion chamber both before and after combustion. The time typically chosen by a furnace manufacturer for post-purge cycles is on the order of 15 to 30 seconds, and as best known to the inventors herein less than 1 minute in virtually all cases. This time is typically set in the furnace control at the factory, is thus typically independent of the installation, and is included in draft hood equipped furnaces indicating that this setting is not seen as having any impact on the condensate issue.

[0014] Therefore, it is an object of the present invention to combine the advantages of an improved blower that overcomes the disadvantages of conventional blowers, including providing a blower that cools the blower motor without the use of an auxiliary fan attached to the blower motor, while at the same time minimizing the condensate formation problem that limits the replacement of old design draft furnaces without the need of a metal vent liner. Still another object of the invention is to eliminate the need for a draft hood or chimney kit for a draft induced furnace and yet still achieve a dry chimney, especially in a replacement installation for a simple draft induced furnace.

SUMMARY OF THE INVENTION

[0015] The present invention overcomes shortcomings of prior art draft induced furnaces that use an auxiliary fan attached to the blower motor to cool the blower motor but which at the same time require the use of a chimney kit or metal vent liner for replacement installations. The blower of the present invention provides cooling for the blower motor with a flow of air induced by the same combustion blower motor and which also incorporates a control that provides a method of operation that achieves a dry chimney in replacement installations of old design draft furnaces. The present invention may also be used with conventional draft induced furnaces that have a combustion blower, without the inventive blower motor cooling feature, to permit them to be retrofit into existing installations as well.

[0016] The blower of the present invention has an impeller that is configured to create a primary air flow of combustion air into the blower housing and a secondary air flow through the blower motor. The secondary air flow is drawn through a casing of the blower motor and into the blower housing where it is mixed with the exhaust gases and discharged from the blower housing. Preferably, the blower housing has an enlarged shaft hole that is sized to allow sufficient cooling air to pass through the motor casing and motor into the blower housing.

[0017] During furnace operation, the impeller of the blower draws air into the vestibule. A first portion of the air is used by the furnace for combustion, and a smaller, second portion of the air is used for cooling the blower motor and exhaust gases. The impeller draws the second portion directly over the motor including its windings into the exhaust stream. Because the second portion is not recircu-
lated with air in the vestibule, it does not contribute to the elevated temperature in the vestibule. As the air in the vestibule has not been recycled by the blower motor, the air in the vestibule is turned over and replaced more rapidly making the vestibule cooler.

The blower of the present invention eliminates the need for an auxiliary fan and allows for the blower to be more compact and streamlined. The blower of the present invention has no external rotating equipment, and the safety concerns and costs incident with the auxiliary rotating fan are obviated. The blower motor of the present invention allows the use of a lower cost blower motor while reducing the noise associated with the blower. When installed in the furnace, the blower of the present invention provides a cooler vestibule and therefore cooler environment for the furnace electronic controls. The blower of the present invention also cools the exhaust stream from the furnace so as to lower overall operating temperatures of the furnace.

Included with the present invention is an appliance control, in the preferred embodiment a furnace control, that may be set to allow for a running of the blower motor for a pre-selected time after each combustion cycle to continue to provide dilution air into the vent and chimney to dry it out. Test data have been obtained using the VENT II program indicating that perhaps as short as a 3 minute run time would provide the desired effect for a typical installation for a 80.5 percent appliance. This provides not only a simple and elegant solution to allow for the retrofit of an appliance using a fan assisted combustion system (FACS) for an older design and less efficient draft appliance, but at less cost and greater effectiveness than with the draft hood solution of the prior art.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Further objectives and features of the present invention are set forth in the following detailed description of the preferred embodiment of the invention and in the drawing figures wherein:

FIG. 1 is a side elevation view of a blower of the present invention;

FIG. 2 is a top plan view of the blower of FIG. 1;

FIG. 3 is a top plan view of the blower of FIG. 1 with a blower motor removed from the blower;

FIG. 4 is a bottom view of the blower of FIG. 1;

FIG. 5 is a cross sectional view of the blower of FIG. 1 taken along the line 5-5 of FIG. 2;

FIG. 6 is a top cross section view of a blower housing of the blower of FIG. 1 taken along the line 6-6 of FIG. 1;

FIG. 7 is a schematic drawing of a conventional low efficiency furnace into which the blower of FIG. 1 is installed;

FIG. 8 is a schematic drawing of a conventional high efficiency furnace into which an alternative embodiment of the present invention is installed; and

FIG. 9 is a schematic drawing of an alternate embodiment of the low efficiency furnace of FIG. 7.

FIGS. 1-6 provide details of the furnace blower 18 of the present invention. The blower 18 is positioned on a blower mounting surface 20 in a furnace 21 and includes a blower motor 22 and a blower housing 24. The blower motor 22 is preferably positioned on top of the blower housing 24 and contained within a motor casing 26. However, the motor 22 and blower housing 24 could have other relative positions. The motor casing 26 is supported on a first side wall 28 of the blower housing 24 by mounting feet 30 extending outward from the motor casing 26. The mounting feet 30 preferably have mounting holes 32, and mechanical fasteners 34 are directed through the mounting holes 32 to secure the motor casing 26 to the first side wall 28 of the blower housing 24.

As shown in FIG. 2, on a top side 36 of the motor 22 opposite the top, first side wall 28 of the blower housing 24, the motor casing 26 preferably has at least one vent hole 38 through the motor casing 26 that leads into an interior 40 of the motor casing 26 surrounding the motor 22. Although several vent holes 38 are shown positioned on the top side 36 of the motor casing 26, the vent holes may also be positioned along a top most edge of side walls 42 of the motor casing 26. As shown in FIG. 5, the motor casing 26 is also provided with a motor casing opening 44 preferably positioned adjacent the first side wall 36 of the blower housing 24. A blower motor shaft 46 extends from the motor 22 in the motor casing 26, through the motor casing opening 44 and into the blower housing 24. The motor casing opening 44 and the vent holes 38 have preferably the same cross sectional area and are preferably positioned on the spaced apart portions of the motor casing 26 to allow cooling air to flow through and cool as much of the motor 22 as possible.

On the blower housing 24 opposite the first side wall 28 is a bottom, second side wall 48 that rests adjacent the blower mounting surface 20 in the furnace 21. An upstanding wall 52 extends between a first and second side walls 28,48, and together the first and second side walls 28,48 and the upstanding wall 52 define a volute 54 of the blower housing 24. The blower housing 24 has a discharge exit 56 leading outward and away from the volute 54. The upstanding wall 52 and the bottom, second side wall 48 have flange portions 58 extending parallel to the blower mounting surface 20 with each of the flange portions 58 having a plurality of matching holes 60. Mechanical fasteners 62 are preferably threaded through the matching holes 60 into the blower mounting surface 20 to secure the blower housing 24 to the furnace 21.

As shown in FIG. 3, the top, first side wall 28 is formed with the upstanding wall 52 and has a shaft hole 64 that leads into volute 54 of the blower housing 24. The shaft hole 64 is preferably aligned with the motor casing opening 44 and receives the motor shaft 46 therethrough. The shaft hole 64 and motor casing opening 44 can have the same cross sectional area so as to not restrict the flow of cooling air from the interior 40 of the motor casing 26 into the blower housing 24.
As shown in FIG. 4, the bottom, second side wall 48 of the blower housing is generally flat so that it may mount flush to the blower mounting surface 20 of the furnace 21. The bottom, second side wall 48 has a center intake 66 leading into the volute 54 of the blower housing 24. The center intake 66 is preferably positioned on the blower mounting surface 20 of the furnace 21 to allow combustion exhaust gases to flow directly into the blower housing 24. The center intake 66 preferably has the same cross section area as the shaft hole 64 and motor casing opening 44 to allow sufficient and balanced flow through the blower 18.

As shown in FIG. 5, the blower housing 24 has an impeller 70 rotatably disposed within the volute 54. The impeller 70 has a circular back plate 72 and a first set of blades 74 on one side of the circular back plate 72 and a second set of blades 76 on the opposite side of the back plate 72. Preferably, the blades of the first and second sets 74, 76 are arranged in a circular pattern on their respective sides of the back plate 72. The first set of blades 74 is positioned adjacent the top, first side wall 28 of the blower housing 24, and the second set of blades 76 is positioned adjacent the bottom, second side wall 48. The blades 74, 76 extend axially away from the back plate 72 and a support ring 78 is provided to hold a distal end 80 of each of the sets of blades 74, 76 in a fixed perpendicular orientation to the back plate 72. In this arrangement, the first set of blades 74 is shorter in axially length than the second set of blades 76 and therefore the first set of blades 74 produces a lower flow rate than the second set of blades 76. The impeller may also be provided with spiral vanes. In this arrangement, the geometry of the vanes is dimensioned so that the first set of vanes generates a lower flow rate than the second set of vanes.

The impeller 70 is operably connected to the motor shaft 46 through a connection bushing 82 located on the circular back plate 72 of the impeller 70. Because the size of the first set of blades 74 is reduced, the connection bushing 82 is preferably positioned on the underside of the circular back plate 72 in the center of the second set of blades 76. In this arrangement, the motor shaft 46 is directed through a center hole 84 in the circular back plate 72 and into the connection bushing 82. A set screw 86 or a press-on connection bushing 82 secures the impeller 70 to the motor shaft 46.

The backing plate 72 on the impeller 70 partitions the impeller 70 into a first section 88 and a second section 90 that is separated from the first section 88. The suction created by each of the sections 88, 90 is separately induced by the rotation and orientation of the respective first and second sets of blades 74, 76. When the impeller 70 is rotated by the motor motor 22, the first set of blades 74 in the first section 88 create a suction at the shaft hole 64 in the top side wall 28, and the second set of blades 76 in the second section 90 create a suction at the intake 66 at the bottom side wall 48. Because the shaft hole 64 is aligned with the motor casing opening 44, the first section 88 draws cooling air through the interior 40 of the motor casing 26 into the blower housing 24 while the second section 90 draws combustion products into the blower housing 24. The impeller 70 compresses the combustion products and cooling air together in the volute 54 and directs the mixed exhaust gases to the discharge exit 56.

The operation of the blower 18 in the furnace 21 will be discussed with reference to FIG. 7 to provide greater detail of the flow paths generated by the blower 18 in the furnace 21. Although the furnace 21 shown in FIG. 7 is a conventional low efficiency furnace (e.g. 50%), a blower 18 of the present invention may also be used in a high efficiency furnace (e.g. 90%) as shown in FIG. 8 with slight modifications to the blower housing to make it leak tight and resistant to higher temperature exhaust and condensate that forms in the exhaust gas stream.

As shown in FIG. 7, the furnace 21 is provided with a main circulation fan 92 that draws a flow of air, generally indicated at reference number 94, from rooms of a house and pushes the flow of air 94 through a heat exchanger 96 around an exterior surface of combustion tubes 98 or combustion chamber, depending on style of furnace, wherein the flow of air 94 is heated and returned back into the rooms of the house.

Separated from the main circulation fan 92 and the duct work that contains the air flow 94 is a vestibule 100 of the furnace 21 and the blower 18 of the present invention. Preferably, the blower 18 is positioned on the blower mounting surface 20 in the vestibule 100 of the furnace 21. The motor casing 26 extends outward into the vestibule 100 with the second side wall 48 of the blower housing 24 mounted adjacent the discharge port of the combustion tubes/combustion chamber 98. The second section 90 of the impeller 70 in the blower 18 draws combustion air, generally indicated at 102, into the vestibule 100 from a furnace room in the house through louvers 104 in a side and top structure of the furnace 21. Then, the second section 90 of the impeller 70 draws the combustion air 102 into the combustion tubes/combustion chamber 98 and into the intake 66 of the blower housing 24 before expelling combustion products, generally indicated at 106, out the discharge exit 56 and into an exhaust pipe 108.

The first section 88 of the impeller 70 draws cooling air, generally indicated at 110, from the vestibule 100 through the vent holes 38 and the motor casing 26, out through the motor casing opening 44, and into the blower housing 24 through the shaft hole 64. The cooling air 110 is then mixed with the hot combustion products 106 as the impeller in the volute of the blower housing compresses the gases 106, 110. The cooling air 110 cools the motor and the motor casing 26 as it is drawn through the motor casing 26 and lowers the temperature of the combustion products 106. Due to the location of the exhaust pipe 108 of the furnace 21 in the vestibule 100, the lower combustion products 106 temperature lowers the temperature of the vestibule 100. In a typical furnace, the vestibule chamber interior also contains the electronics and controls 111 to control the operation of the blower and furnace 21. The flow of air 102 being drawn into the vestibule 100 along with the lower vestibule temperature cools the control electronics 111.

As shown in FIG. 8, the arrangement of the blower in a high efficiency furnace 21 produces flow paths through the furnace 21 that are similar to those described above with reference to the low efficiency furnace 21 of FIG. 7. The blower 18 draws the combustion air 102 into the vestibule 100 before entry in the combustion tubes/combustion chamber 98. The blower 18 is positioned in the vestibule 100 where the first section 88 of the impeller 70 may draw
cooling air 110 directly from the vestibule 100 and through the motor casing 26. The second section 90 draws combustion products 106 into the blower where the combustion products are mixed with the cooling air 110 and discharged out the exhaust pipe 108. Because in the high efficiency furnace 21 the combustion air 102 is drawn from outside the house, the vestibule 100 is provided with an inlet pipe 112.

[0044] FIG. 9 shows an alternate embodiment of a low efficiency furnace 21" in which the blower 18 of the present invention is installed. In this embodiment, combustion air 102 is drawn into the vestibule 100 through louvers 104 in a top structure of the furnace 21". The flow of combustion products 106 and cooling air 110 through the blower 18 is similar to that described above with reference to FIG. 7.

[0045] The blower of present invention provides improved cooling for the blower motor and the several other advantages described above. The blower may be used in a furnace or other type of appliance such as a hot water heater or clothes dryer or any other Category I or III fuel burning appliance where combustion products must be actively evacuated from the appliance through a chimney. The blower motor may be a single speed motor, or a variable or multi-speed motor, depending on design choice.

[0046] The control 111 for a furnace may be an integrated control in the form of a computer or other digital circuit, as is commonly found in present day designs, and its operating parameters may be determined by software loaded into the control. Alternatively, or in conjunction therewith, the installer or even a serviceman may be provided access to check and even alter these settings through a keyboard or other input device which may be connected to the control or with a control panel provided. Various kinds of controls may be used and even electromechanical controls provided with a discrete timer which may be set to achieve the purposes of the present invention.

[0047] The present invention includes a control that may be set, either in software or hardware or otherwise, to provide a run time after a combustion cycle during which ambient air is introduced into the vent or exhaust flue. Attached hereto are Exhibits A and B of data generated by the VENT II program which demonstrate the effectiveness of the present invention. Exhibit A represents essentially a "worst case" scenario for a typical installation in which the furnace has been chosen to be a 100,000 btu, 80.5 percent efficiency furnace with a 1 foot vertical and 5 foot horizontal 6 inch flue feeding a 20 foot chimney with an 8 minute combustion time every 20 minutes. With these conditions, as simulated in the program, it has been found that a dry chimney can be achieved with as short as a 3 minute run time after each combustion cycle. Exhibit B is the data for the same installation, except that the furnace is 83 percent efficient, in which a dry chimney can be achieved with as short as a 4 minute run time after each combustion cycle. Thus, using the computer program developed and used to generate data for the Gas Research Institute Topical Report referenced above, a simulation has been shown to achieve a dry chimney for an 83 percent efficient appliance which was impossible to achieve with the operating modalities reported therein.

[0048] While the present invention has been described by reference to specific embodiments, it should be understood that those embodiments are intended by the inventors to be merely illustrative and not limiting. Modifications and variations of the invention may be constructed without departing from the scope of the invention as defined by the following claims and their legal equivalents. For example, while the inventors have demonstrated the operability of the invention in the context of a typical installation, it is noted that an idealized run time may be calculated for each installation. However, it is anticipated that appliance manufacturers will set the "run time" at the factory to be more than adequate for every expected installation both for safety and ease in manufacture. Other factors which the furnace manufacturers may take into account are the desire to shorten the "run time" to minimize the noise that the furnace makes within the house as well as a lower usage of the combustion fan. Furthermore, the blower motor may well be a variable speed or multi-speed motor so that it may be run at a different speed during the run time than during combustion. For a shortened run time, the motor may perhaps be run at a faster speed. For a less objectionable noise level, the motor may perhaps be run at a slower speed. These kind of parameters could be determined as a matter of design choice by a run time of the art and to satisfy the preferences of the designer and are thus not seen to affect to the present invention. This "safe" run time may be well in excess of any calculated "worst case" scenario of a typical installation that resulted in the 3 minute run time disclosed in the preferred embodiment. For example, a 6 minute run time may be chosen. However, care will need to be taken to avoid the apparently limiting case demonstrated in the Gas Research study that found that a continuous run time was not effective, even for an 80.5 percent efficient furnace, in achieving a dry chimney in a typical installation. Furthermore, the post-purge run time of the prior art has not been demonstrated to achieve a dry chimney, being apparently under a minute at its longest, and hence providing a lower limit than the 3 minute limit known to the inventors.

[0049] While the inventors have determined that a pre-selected, fixed, and repetitive run time is effective in achieving the purposes of the invention, it may be that further experimentation would demonstrate that the run time could be varied and yet the chimney would be dry. For example, the run time could be calculated at the end of each combustion cycle as a fraction or otherwise be related to the actual combustion cycle time, so that the run time would vary for each combustion cycle. For an 8 minute combustion cycle, a 75% run time would require a 6 minute run time. Should the furnaces require a 4 minute combustion cycle to heat the house, given the outside temperature and other factors present at that moment, then a 3 minute run time would occur. Thus, with this operating modality, a different run time would be used before each combustion cycle and yet the data might very well demonstrate a dry chimney had been achieved. Additionally, it could be that a run time could be provided after fewer than every combustion cycle and yet still achieve a dry chimney within the parameters of the appropriate standard. For example, a run time could be provided after every other combustion cycle, or every two out of three combustion cycles, etc.

[0050] As the control is typically an electronic logic device, including a microprocessor, an even more sophisticated operation may be provided wherein the computing and monitoring capabilities of the control could be more fully utilized. For example, the control will have data corresponding to the frequency at which the appliance is operating as
well as the time period for each combustion cycle. The control could thus use this information to custom calculate and effect a run time and frequency adapted to a particular, and ever changing, operating environment. As anyone can appreciate, an appliance such as a gas fired furnace will experience a differing operation or duty cycle comprising a differing frequency and duration of combustion depending on many variables including the particular home within which it is installed, the particular temperature of the day, sun loading, the setting of the home thermostat, the relative humidity both inside and outside the home, the efficiency of combustion including the air/gas mix, etc. All of these variables have an impact on the furnace duty cycle, but the furnace typically runs in response to the single setting of a thermostat. Similarly, the furnace manufacturer may not want to set the control for a fixed run time after combustion and instead allow the control to be more responsive to the actual conditions experienced by the furnace, as evidenced by its duty cycle. The inventors believe that a person of ordinary skill in the art, using the teaching of the present invention, could readily determine what range of run times and corresponding frequencies for after combustion blower operation would be required for a given furnace duty cycle in order to achieve a dry chimney. Furthermore, it is anticipated that there is some readily determinable working relationship between the blower run time duration and frequency such that a control could be set to optimize either for a minimum run time or a minimum frequency, or to optimize both in combination to suit the designer’s preferences. In this way, the control could take a more active role in determining the post combustion blower run time and frequency to be used for any given operational cycle as experienced by the appliance.

[0051] These different kind of operating modalities are considered by the inventors to be within the scope of the present invention.

[0052] Still another advantage of the present invention is its versatility. It can not only be used with the fanless motor cooling invention of the parent, but may also be used with a prior art induced draft furnace or other appliance. It is only required that the appliance have a combustion fan which may be operated after a combustion cycle to provide dilution or ambient air into the chimney.

[0053] As mentioned above, the embodiments disclosed herein are intended to be illustrative and the invention is intended to be limited solely by the scope of the claims appended hereto and their legal equivalents.

What is claimed is:

1. A method for drying the condensate from an exhaust flue for a fuel burning appliance, said fuel burning appliance having a combustion blower to exhaust the products of combustion from a combustion chamber into the exhaust flue, the method comprising the step of running the combustion blower after the end of a combustion cycle for a time at least longer than a post purge time period but less than continuously.

2. The method of claim 1 wherein the running step includes the step of running the combustion blower for at least approximately three minutes after the end of a combustion cycle.

3. The method of claim 2 further comprising the step of running the combustion blower after the end of each combustion cycle for the same time period.

4. The method of claim 3 wherein the exhaust blower includes an electric motor and further comprising the step of drawing in some ambient air through the electric motor.

5. The method of claim 3 wherein the fuel burning appliance further comprises a control, and further comprising the step of setting the control to run the combustion blower for at least three minutes after the end of a combustion cycle.

6. The method of claim 5 further comprising the step of running the exhaust blower at a different speed after the end of a combustion cycle.

7. The method of claim 6 wherein the motor is a variable speed motor and the step of running the exhaust blower at a different speed comprises the step of changing the speed at which the variable speed motor runs.

8. The method of claim 6 wherein the motor is a multi-speed motor and the step of running the exhaust blower at a different speed comprises the step of changing the speed at which the multi-speed motor runs.

9. The method of claim 2 wherein the fuel burning appliance further comprises a control, and further comprising the step of setting the control to run the combustion blower for at least three minutes after the end of each combustion cycle.

10. The method of claim 9 further comprising the step of running the exhaust blower at a different speed after the end of a combustion cycle.

11. The method of claim 10 wherein the motor is a variable speed motor and the step of running the exhaust blower at a different speed comprises the step of changing the speed at which the variable speed motor runs.

12. The method of claim 10 wherein the motor is a multi-speed motor and the step of running the exhaust blower at a different speed comprises the step of changing the speed at which the multi-speed motor runs.

13. A fuel burning appliance having an exhaust outlet adapted for connection to an exhaust flue, an exhaust blower for exhausting products of combustion through said exhaust outlet, and a control for controlling the operation of the exhaust blower, the control being configured to run the exhaust blower after the end of a combustion cycle for a time at least longer than a post purge time period but less than continuously to thereby ensure that the exhaust flue dries of condensate formed therein by said products of combustion.

14. The fuel burning appliance of claim 13 wherein said control is configured to run the exhaust blower after the end of a combustion cycle for at least approximately three minutes but less than continuously.

15. The fuel burning appliance of claim 14 wherein said exhaust blower has an electric motor, and further comprising a connection between said motor and a blower housing through which ambient air is drawn as the exhaust blower is operated.

16. The fuel burning appliance of claim 14 wherein said electric motor comprises a variable speed motor and said control is configured to run said electric motor at a different speed during a combustion cycle than after a combustion cycle.

17. The fuel burning appliance of claim 14 wherein said electric motor comprises a multispeed motor and said con-
control is configured to run said electric motor at a different speed during a combustion cycle than after a combustion cycle.

18. The fuel burning appliance of claim 13 wherein said control is configured to permit the exhaust blower post combustion cycle run time to be adjusted.

19. A fuel burning appliance having an exhaust outlet adapted for connection to an exhaust flue, an exhaust blower for exhausting products of combustion through said exhaust outlet, and a control for controlling the operation of the exhaust blower, the control being configured to run the exhaust blower after the end of each combustion cycle for at least about three minutes to thereby ensure that the exhaust flue dries of condensate formed therein by said products of combustion.

20. The fuel burning appliance of claim 19 wherein said exhaust blower has an electric motor, and further comprising a connection between said motor and a blower housing through which ambient air is drawn as the exhaust blower is operated.

21. The fuel burning appliance of claim 20 wherein said electric motor comprises a variable speed motor and said control is configured to run said electric motor at a different speed during a combustion cycle than after a combustion cycle.

22. The fuel burning appliance of claim 20 wherein said electric motor comprises a multi-speed motor and said control is configured to run said electric motor at a different speed during a combustion cycle than after a combustion cycle.

23. A method for drying the condensate from an exhaust flue for a fuel burning appliance, said fuel burning appliance having a combustion blower to exhaust the products of combustion from a combustion chamber into the exhaust flue, the method comprising the step of running the combustion blower after the end of a combustion cycle for at least about three minutes but less than continuously.

24. The method of claim 23 further comprising the step of drawing at least some ambient air into the exhaust blower at least during the time period after the end of the combustion cycle.

25. The method of claim 24 wherein the exhaust blower includes an electric motor and wherein the step of drawing in some ambient air includes the step of drawing in some ambient air through the electric motor.

26. The method of claim 25 wherein the fuel burning appliance further comprises a control, and further comprising the step of setting the control to run the combustion blower for at least three minutes after the end of a combustion cycle.

27. The method of claim 26 further comprising the step of running the exhaust blower at a different speed after the end of a combustion cycle.

28. A method for drying the condensate from an exhaust flue for a fuel burning appliance, said fuel burning appliance having a combustion blower to exhaust the products of combustion from a combustion chamber into the exhaust flue, the method comprising the step of running the combustion blower after the end of each combustion cycle for a fixed period of time equal to at least three minutes but less than continuously.

29. The method of claim 28 wherein the exhaust blower includes an electric motor and further comprising the step of drawing in some ambient air through the electric motor.

30. The method of claim 29 wherein the fuel burning appliance further comprises a control, and further comprising the step of setting the control to run the combustion blower for at least three minutes after the end of each combustion cycle.

31. The method of claim 30 further comprising the step of running the exhaust blower at a different speed after the end of each combustion cycle.

32. A method for drying the condensate from an exhaust flue for a fuel burning appliance, said fuel burning appliance having a combustion blower to exhaust the products of combustion from a combustion chamber into the exhaust flue and a control configured to control the operation of said blower, the method comprising the step of determining a duty cycle for said combustion blower to thereby ensure that the exhaust flue dries of condensate formed therein by said products of combustion.

33. The method of claim 32 wherein the determining step includes the step of determining either of the frequency or duration of blower run time after appliance combustion cycles.

34. The method of claim 33 wherein the control is configured to perform the determining step.

35. The method of claim 34 wherein the determining step includes the step of determining a frequency for blower run time after combustion.

36. The method of claim 34 wherein the determining step includes the step of determining a frequency for blower run time after combustion.

37. The method of claim 32 wherein the step of determining said blower duty cycle includes determining blower run time after combustion to be a time greater than a post purge time period but less than continuously.

38. The method of claim 32 wherein the step of determining includes the step of determining the duty cycle for the exhaust blower in response to the appliance duty cycle.

39. A fuel burning appliance having an exhaust outlet adapted for connection to an exhaust flue, an exhaust blower for exhausting products of combustion through said exhaust outlet, and a control for controlling the operation of the exhaust blower, the control being configured to determine a duty cycle for the exhaust blower to thereby ensure that the exhaust flue dries of condensate formed therein by said products of combustion.

40. The fuel burning appliance of claim 39 wherein said control is configured to determine a post combustion blower run time greater than a post purge time period but less than continuously.

41. The fuel burning appliance of claim 39 wherein said control is configured to determine a frequency for blower run time after combustion.

42. The fuel burning appliance of claim 39 wherein said control is configured to determine the duty cycle for the exhaust blower in response to the appliance duty cycle.