CONTROL SYSTEM FOR HEATING SYSTEMS

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ABSTRACT

Provided are exemplary embodiments, which may include a heating system controller, which may be capable of controlling a heating system to reduce inefficiencies, and/or allow the heating system to operate in a relatively optimum manner.
FIG. 3
CONTROL SYSTEM FOR HEATING SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS


TECHNICAL FIELD

[0002] The present disclosure relates generally to heating systems and, in particular, to a closed-loop controller for providing control of various aspects of a heating system.

BACKGROUND

[0003] Various heating systems, including fireplaces and furnaces for home installations, may have been made available to consumers in recent years with improved control systems. Despite improvements, such heating systems may be limited in the ability to control the heat distribution from the heating system to the area to be heated.

[0004] For example, while current heating systems have frequently utilized various techniques to separate the combustion air from the room air, such as direct air venting systems, very little has been done to improve heat transfer and distribution. Furthermore, feedback from the heating system may aid in increasing efficiency of the system. This efficiency may include decreasing the amount of spent, unused fuel, maintaining a generally optimum temperature and determining if various augers are jammed or not working properly, among other variables.

SUMMARY

[0005] In accordance with various aspects of exemplary embodiments, a heating system transfer controller may be configured to control variables of the heating system, such that the heating system may operate more efficiently. In accordance with an exemplary embodiment, an exemplary heating system may include a fuel auger, air intake, an exhaust vent, a combustion chamber and a controller. The heating system may include various types of heating configurations, such as fireplaces, stoves, furnaces or other like heating systems. The air intake is configured to receive external air into the heating system, while the exhaust vent is configured to remove exhaust from within the heating system. Both the air intake and exhaust vent can be configured in various manners, shapes and sizes for providing the respected air intake and heat exhaust functions.

[0006] In accordance with one aspect of exemplary embodiments, the heating system controller may be configured to control various portions of the heating system based, at least in part, upon the pressure within the combustion chamber. In accordance with another exemplary embodiment, the heating system controller may determine a portion of the heating system is not operating properly, based at least in part upon feedback from sensors of the system.

[0007] In an embodiment, various portions of a fireplace system may be manipulated to reduce inefficiencies of the system. These inefficiencies may include, but are not limited to, inadequate burning of the fuel, inadequate amount of fuel, different types of renewable fuel such as wood pellets, wheat, and/or corn, and/or other fuel, and/or combinations thereof, and different fuel grades, inefficient heat transfer from the combustion chamber, non-optimal pressure in the combustion chamber, inefficient temperature in the combustion chamber, and/or inefficient amount of ash within the combustion chamber, and/or other inefficiencies, and/or combinations thereof.

[0008] Other inefficiencies may also include inefficiencies due to different types of fuels, variations in size of fuels, moisture content, and/or different atmospheric conditions, and/or combinations thereof.

[0009] In accordance with other aspects, the heating system controller may be capable of controlling variables of the heating system based at least in part upon signals and/or information received from sensor of the heating system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The exemplary embodiments may be described in conjunction with the appended drawing figures in which like numerals denote like elements and:

[0011] FIG. 1A is a block diagram of an exemplary heating system in accordance with an exemplary embodiment;

[0012] FIG. 1B is a cross-sectional view of a heating system in accordance with an exemplary heating system according to an exemplary embodiment;

[0013] FIG. 2 is a block diagram of an exemplary control system in accordance with an exemplary embodiment; and

[0014] FIG. 3 illustrates a user interface in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

[0015] The present disclosure may describe various functional components. It should be appreciated that such functional components may be realized by any number of hardware components, electrical and mechanical, configured to perform the specified functions. In addition, exemplary embodiments may be practiced in any number of heating system contexts, and the fireplace systems described herein are merely one exemplary application.

[0016] Referring now to FIG. 1, in accordance with an exemplary embodiment, a solid fuel heating device 10 having a combustion chamber 12 is illustrated. In an embodiment, a heat exchange arrangement in the form of hollow pipes 19 can be disposed towards the top end of combustion chamber 12 and may be heated hot air from combustion chamber 12. Ambient air, as indicated by arrows 22, may be circulated through hollow pipes 19 by a fan 21 mounted in a side wall of the heating device, or any other convenient location, such as proximate the hot air exhaust area, to exhaust heated air from pipes 19 into the ambient air, in a direction indicated by arrows 22. This may be accomplished to heat the surrounding area of heating device 10. Fan 21 may be configured in various locations for circulating ambient air through pipes 19, with such pipes 19 being arranged in various manners for discharging heat to the surrounding area.

[0017] In an embodiment, the convection and combustion flow system may also be used in other manners by utilizing heat transfer devices to extract heat, including flat and/or accordion plate heat exchangers, air flow passages for exhaust and/or convection air, casting, hot air intake, and/or other methods and systems for discharging heat to the surrounding environment.
area. The utilization of heat exchangers with a stove may increase the efficiency of the system, increase the convection temperature, and/or lower the exhaust temperature, and/or combinations thereof.

[0018] Furthermore, combustion and convection air flow may be configured to be parallel, counter, and/or cross flow, and/or combinations thereof to further increase efficiency. In an embodiment, heat exchange between the convection and combustion air, heat exchange between the air intake and the exhaust air, mixing the exhaust air with the air intake, etc. may make the system more efficient.

[0019] Many different types and configurations of heat exchangers may be utilized with the system. A corrugated surface plate, or a casting made from copper or other high heat transfer coefficient material may be positioned between different air flows to enhance heat transfer. Utilizing finned tubes may further increase the surface area and increase the heat transfer characteristics of the system. Furthermore, the alteration of the air flow devices to create turbulence or other disruption may further increase efficiency.

[0020] Other types of heat exchangers, such as heat pipes, or condensers may also be utilized to enhance heat transfer, as they may utilize the phase shifts of fluids to release heat at a much higher rate. Furthermore, there may be other heat exchangers that enhance heat transfer such as coaxial venting, radiator, spiral plated exchangers, and/or any other heat exchanger that may enhance heat transfer.

[0021] Heating system 10, as herein illustrated in the exemplary embodiment, may be a biomass pellet, fuel, and/or grain-fed, and/or other fuel, and/or combinations thereof, space heating stove. The system may include a "key," which may allow the system to utilize different fuels. The key may be added to allow the use of various type of fuel. The system may allow a user to switch fuel type without shutting down the system.

[0022] In an embodiment, system 10 may include a hopper 23. Hopper 23 may be configured for storage of fuel sources, such as solid fuel pellets 24, for example. Hopper 23 may be various sizes, shapes, and configurations for storage of fuel. In an exemplary embodiment, fuel pellets 24 may be fed into a fuel bed 25 of combustion chamber 12 by an auger 26 feeding a chute 27.

[0023] In the exemplary embodiment, solid fuel pellets 24 entering combustion chamber 12 may be projected into fuel bed 25 by gravity and supported by a support mechanism in the form of a support tray 28. Support tray 28 may be fixedly secured under the bottom, open end of the inner wall 16. An ash collecting tray 29 may be removable secured under this support tray 28 and accessible through a door 30. A sensor may be included, which may alert a user that the ash pan is full. This may indicate that the pan should be emptied. If the pan is not emptied, the system may shut down, or other sequence, to protect the system.

[0024] Solid fuel pellets and grains (fuel) 24 may also be fed from the bottom or the side of the unit, or any other configuration for providing fuel, and the like, onto fuel bed 25. For example, rather than hopper 23 and/or auger 26, many other mechanisms or systems for conveying materials may be suitably implemented.

[0025] The system may be capable of operating a high-efficiency burn mode, or a clean burn mode, which may be user selectable.

[0026] Shown in FIG. 2 is a block diagram of an exemplary heating system 200. In an embodiment, system 200 may be connected to a user interface 61, which may be provided with an internal memory 62. User interface 61 may allow a user to input information to controller 60. Furthermore, user interface may allow a user to control certain aspects of the heating system 200. In an embodiment, user interface 61 may also be capable of transmitting user input, which may condition the controller to operate within a stored programmed mode of operation, depending on the type of fuel being fed to the burner. Variables such as temperature, type of fuel, and many other variables may be controlled by controller 60 via user interface 61.

[0027] In an embodiment, system 200 may include software, hardware, and/or firmware, and/or combinations thereof to control the various aspects of the system. The software/hardware/firmware may be capable of being upgraded to allow for improved, and/or different modes of operation.

[0028] In an embodiment, an exemplary controller 60 may be provided with input signals from a temperature sensor 64 that senses the temperature of the heating device 10. In an embodiment, temperature sensor 64 may be located on a wall of the heating device, and/or other suitable location. Controller 60 may also monitor input signals from an operational thermo sensor 65, which may be capable of indicating that a flame is present in the burner chamber. Temperature sensor 64 may be located on the outside, back wall, and/or other suitable location of combustion chamber 12 to sense the temperature thereof. For example, if temperature sensor 64 detects a predetermined high temperature signal, controller 60 may shut off the fuel feed auger that delivers the fuel to the fuel bed of the fuel burner, thus commencing an orderly automatic shutdown of device 10. Accordingly, controller 60 may be capable of modulating the operation of the system to maintain a desired temperature output.

[0029] In an embodiment, heating system 200 may include a hopper sensor 40, which may be capable of detecting the amount of fuel within the hopper. Hopper sensor 40 may be further capable of indicating various levels of fuel in the hopper to controller 60, such that the level may be displayed, and/or an alert may be generated indicating various levels of fuel, such as too low and too high, among many others.

[0030] In an embodiment, heating system 200 may also include a pressure sensor 66, which may be positioned to be capable of measuring the pressure within combustion chamber 12. Controller 60 may receive a signal from pressure sensor 66, which may indicate a pressure level in combustion chamber. There may be a particular pressure range, which may generally correspond to a relatively optimal burn conditions for the system. In an embodiment, if the pressure is outside of a range, controller 60 may then control other aspects of the system based at least in part on the pressure. For instance, if the pressure is lower than the optimal range, the controller may increase the combustion fan speed to add more pressure to the combustion chamber, or slow down the feed auger to accommodate pressure drop.

[0031] System 200 may also include a fuel level sensor 67, which may be capable of indicating the level of the fuel available to the system. Sensor 67 may be capable of detecting the amount of fuel within the hopper. Sensor 67 may be further capable of indicating various levels of fuel in the hopper to controller 60, such that the level may be displayed, and/or an alert may be generated indicating various levels of fuel, such as too low and too high, among many others. Controller 60 may receive a signal from fuel level sensor; and
indicate via user interface 61, or other method or system, the fuel level, and/or high or low levels of fuel available. In the embodiment shown in FIG. 1, the level, and/or high and low levels of the solid fuel may be measured and indicated.

Controller 60 may also be capable of controlling the speed of combustion fan 68, which may be located within heating device 10 as illustrated in FIG. 1, or otherwise outside, or in in-flow communication, to facilitate intake and exhaust air. Controller 60 may also control the speed of convection fan 21, which may be used to force the air through heat exchangers 19.

Controller 60 may also control ash auger 54, which may be capable of evacuating the ashes depending on the operating parameters of the system and high or low ash fuel type. In an embodiment, system 200 may include a sensor 254, which may be capable of measuring the speed of ash auger 54 and/or operation of ash auger 54. Alternatively, sensor 254 may indicate whether or not ash auger 54 is moving. If controller 60 is sending a signal for ash auger 54 to run, and sensor 254 indicates that ash auger 54 is operating abnormally, or not at all, this may indicate to controller 60 that the ash auger system is not operating properly. Controller 60 may then control system 200 to insure that no damage is done, either to the system or to the surrounding area. The above-mentioned control may include an orderly shutdown of the system, and/or an alarm to alert the user.

The system may also include a content sensor 255, which may be capable of sensing the amount of moisture and/or carbon content within the fuel in the fuel bed to insure the fuel is burnt to a degree to allow the ash auger to remove the fuel. Other sensors may include a sensor capable of detecting and alerting when the system may need to be cleaned and/or serviced.

Similarly, system 200 may include a feed auger 26, which may be controlled by controller 60. In an embodiment, feed auger 26 may be configured to provide solid fuel to system 200. In an embodiment, system 200 may include a sensor 226, which may be capable of measuring the speed of feed auger 26, and/or the presence of fuel in the auger. Alternatively, sensor 226 may indicate whether or not feed auger 26 is moving. If controller 60 is sending a signal for feed auger 26 to run, and sensor 226 indicates that feed auger 26 is operating abnormally, or not at all, this may indicate to controller 60 that the feed auger system is not operating properly. Controller 60 may then control system 200 to insure that no damage is done, either to the system or to the surrounding area. The above-mentioned control may include an orderly shutdown of the system, and/or an alarm to alert the user. Furthermore, the controller may insure that no backfire may occur.

Similar sensors may be provided in other areas of the system including, but not limited to, the combustion and convection fans. A power supply 69 may provide power for the controller and interface, which, in an embodiment, may be 12 VDC. In an embodiment, a system may also include a battery backup. The system may also have the capability to change to battery power during a power outage, indicate the power outage, and that the battery is in use. Furthermore, the charge remaining in the battery may also be indicated.

Referring now to FIGS. 1, 2, and 3 in accordance with exemplary embodiments, there will be described the operation of an exemplary controller 60. This controller 60 may be coupled to a user interface 61, which may be provided with an internal memory 62 (see FIG. 2). In the embodiment of FIG. 3, user interface 61 includes a keypad-type configuration, with a display 76. In embodiments, display 76 may be an LED-type display, and/or an LCD-type display. Other display types may be utilized without straying from the concepts disclosed herein.

Furthermore, user interface 61 may be configured to allow a user to control and/or manipulate the operation of the solid fuel biomass pellet heating device 10, such as the system illustrated in FIG. 1.

Controller 60 may be configured to control the motor(s) and the fans, and inputs and operating parameters utilizing information from the sensors. To start the operation of a biomass pellet device 10, a user may actuate the button labeled “Start” 78. This may cause the pellets to be automatically fed to the burner and ignited by an ignition device, to create an initial fuel bed. Other steps may then be accomplished to start the operation of heating system 10, such as starting the system with a fire starter, and/or starting with one fuel and continuing the burn with another fuel. Other ignition methods may be utilized, including utilization of an air pump and an igniter to assist in creating a torch effect, and/or more than one ignition source. Furthermore, a user may turn off the heating device by depressing the button labeled “Stop” 80.

In an embodiment, the “Service” actuator 82 may activate diagnostics for the system. The diagnostics may include turning the burn to compensate for atmospheric conditions, and/or variations in fuel, and fuel quality. It will be appreciated that the diagnostics of the system may include many other diagnostics.

In an embodiment, the user may select a desired mode of operation of device 10 by inputting desired parameters into the controller by the use of interface pad 61. Interface pad 61 can also be provided with heat level buttons 73, which may control the amount of heat produced by the system. This may increase or decrease the temperature in combustion chamber 12. This increase may cause an increase in the temperature of the heated air released by the biomass pellet device through the heat exchanger located above the flame, which may be regulated by a separate fan. All of these operating parameters may be capable of being stepped up or down, to maintain relatively optimum performance levels and/or to decrease inefficiencies of the system, according to the desired heat performance required of the device.

Additionally, the entire system can operate from a remote thermostat to regulate all of these operating parameters based at least in part upon the setting(s) of the thermostat. User interface 61 may also be removed from the system and be used remotely. A “Prime Stove” actuator 72 may be provided, which may be capable of activating a method for manually priming the heating device. This may be due to the various types and/or qualities of the fuel being utilized. Priming may not be necessary for all fuels, types, and/or qualities.

Inputs from actuators may be sent to the controller, which may regulate the speed of the motor, which drives the ash auger. Control switches 73 may also be utilized to set a desired BTU output of the pellet stove. Through the software of the controller, the type of fuel and substantially optimal operating conditions of the device may be regulated and maintained.

User interface 61 may also include a fuel selection button 70, which may be configured to indicate to the controller the fuel that will be used. Different choices for fuel may appear within display 64. The user may then depress “Heat” actuator 74, which may allow a user to adjust the heat.
level using buttons 73. This may allow the controller to control various aspects of the system based at least in part upon the type of fuel being used by the system. In an embodiment, the types of fuel shown are solid fuels. However, other fuels, such as non-solid fuels, may also be utilized.

[0045] User interface 61 may be attached to the system, or may be a remote control. Furthermore, user interface 61 may also be capable of communicating with other devices within the heating environment to further control the operation of the system. In one embodiment, another device may be a temperature sensor that may interface with the system.

[0046] The present invention sets forth a heat transfer controller that is applicable to various heating system applications. It will be understood that the foregoing description is of exemplary embodiments of the invention, and that the invention is not limited to the specific forms shown. Various modifications may be made in the design and arrangement of the elements set forth herein without departing from the spirit and scope of this disclosure. For example, the sensors utilized are not limited to those shown herein. Furthermore, other user interfaces may be utilized as well. Many other processors/controllers, as well as sensors may be utilized without straying from the concepts disclosed herein. These and other changes or modifications are intended to be included within the scope of the present invention, as set forth in the following claims.

What is claimed is:
1. A heating system comprising: a fuel input, configured to receive a plurality of fuels; a fuel key; and a controller in electronic communication with said fuel key; wherein said fuel key is configured to provide said controller with operating parameters such that said heating system operates during a change from a first fuel type to a second fuel type.
2. The heating system of claim 1, further comprising a pressure sensor configured to provide a measured pressure to said controller.
3. The heating system of claim 2, wherein said controller is further capable of controlling one or more variables of the heating system based at least in part upon the measured pressure.
4. The heating system of claim 1, further comprising a feed auger, wherein said controller is configured to control the operation of said feed auger.
5. The heating system of claim 1, further comprising a content sensor in electronic communication with said controller.
6. The heating system of claim 5, wherein the content sensor is configured to measure at least one of carbon content and moisture content of said fuel.
7. The heating system of claim 5, further comprising a fuel bed configured to contain said fuel during combustion, wherein said content sensor is operatively coupled to said fuel bed.
8. The heating system of claim 1, further comprising a convection fan in electronic communication with said controller, wherein said controller is configured to control the operation of the convection fan.
9. The heating system of claim 1, wherein the controller comprises a user interface configured to receive inputs from a user to affect the operation of said heating system.
10. A fireplace system, comprising: a fuel input, configured to receive a plurality of fuels; a controller configured to adjust an operating variable of said fireplace to achieve a relatively optimum operation; and a fuel key configured to provide operating parameters to said controller such that said fireplace system continues to operate during a change from a first fuel type to a second fuel type.
11. The fireplace system of claim 10, further comprising a feed auger, wherein said operating variable is a speed of said feed auger.
12. The fireplace system of claim 10, further comprising a combustion fan, wherein said operating variable is a speed of said combustion fan.
13. The fireplace system of claim 10, further comprising a fuel hopper, wherein said operating variable is an amount of fuel in said fuel hopper.
14. The fireplace system of claim 10, wherein the controller comprises a user interface capable of receiving inputs from a user to manipulate operation of said fireplace system.
15. The fireplace system of claim 14, wherein the user input is has plurality of selectable operating modes, and wherein the plurality of operating modes includes at least one of a high efficiency burn mode and a clean burn mode.
16. A method for reducing inefficiencies in a heating system comprising: providing a fuel input configured to receive a plurality of fuel types; receiving, by a controller, operating parameters from a fuel key; generating heating with a first fuel type; and adjusting, by the controller, an operating condition of said heating system in response to receiving a second fuel type based on said operating parameters; wherein said residential stove system operates during a change from said first fuel type to said second fuel type.
17. The method of claim 16, further comprising receiving, by said controller, a signal from a sensor, wherein the signal represents at least one of an operating characteristic of said heating system which corresponds to operation of a component of said heating system and a combustion characteristic of a combusting fuel type.
18. The method of claim 17, wherein said sensor is a content sensor and said signal corresponds to at least one of a level of carbon of said combusting fuel and a level of moisture of said combusting fuel.
19. The method of claim 16, further comprising, adjusting said combustion fan speed to adjust a pressure of a combustion chamber.
20. The method of claim 16, further comprising, receiving, by said controller, a user input to manipulate an operating condition of said heating system, wherein said controller comprises a user interface configured with selectable inputs.
21. A heating system, comprising: a combustion chamber in which a fuel is utilized to create heat; a content sensor configured within said combustion chamber, said content sensor configured to monitor at least one of a moisture content and a carbon content of said fuel within said combustion chamber; a controller in electronic communication with said content sensor and capable of controlling said heating system to operate to reduce inefficiencies of the heating system,
wherein said content sensor are configured in a closed-loop feedback arrangement to facilitate control of said heating system.

22. The heating system of claim 21, further comprising a fuel level sensor configured to sense a fuel level wherein the controller is configured to deliver a message in response to the fuel level being at least one of above a first predetermined threshold and below a second predetermined threshold.

23. The heating system of claim 21, wherein the controller is configured to receive a removable key and wherein said removable key is configured with operating parameters for said plurality of fuels.

24. The heating system of claim 21, further comprising an ash pan configured to receive ash from said combustion chamber an ash sensor operatively coupled to said ash pan and configured to monitor a level of ash in said ash pan, wherein in response to said ash reaching a predetermined level said controller adjusts said heating system to prevent damage to said heating system.

25. The heating system of claim 21, further comprising an ash auger in electronic communication with said controller, wherein said ash auger removes ash from the combustion chamber in response to at least one of the moisture content and the carbon content being at a level to indicate that said fuel is sufficiently burnt such that the ash can be removed by said ash auger.

26. A heating system, comprising:
   a controller configured to reduce operating inefficiencies of said heating system;
   a combustion chamber in which fuel is utilized to create heat;

   an ash sensor in electronic communication with said controller and coupled to said combustion chamber and configured to monitor a level of ash; and
   an ash auger in electronic communication with said controller and operatively coupled to said combustion chamber, said ash auger configured to remove ash from said combustion chamber in response to a command from said controller, wherein said command is generated by said controller in response to a signal from said ash sensor indicating said level of ash exceeds a predetermined amount.

27. The heating system of claim 26, further comprising a fuel key in electronic communication with said controller, said fuel key configured to communicate a fuel type to said controller, such that said controller adjusts said heating system to reduce said inefficiencies for one of said plurality of fuel types.

28. The heating system of claim 26, further comprising a heat exchanger in thermal communication with said combustion chamber such that thermal energy generated in said combustion chamber is conducted through said heat exchanger to an environment.

29. The heating system of claim 28, wherein the heat exchanger comprises a plurality of pipes in fluid communication with the environment.

30. The heating system of claim 26, further comprising a pressure sensor operatively coupled to said combustion chamber and in electronic communication with said controller, wherein a pressure in said combustion chamber is measured and communicated to said controller.