



(22) **Date de dépôt/Filing Date:** 2013/10/16

(41) **Mise à la disp. pub./Open to Public Insp.:** 2014/04/30

(45) **Date de délivrance/Issue Date:** 2016/05/10

(30) **Priorités/Priorities:** 2012/10/31 (US61/720,906);
2013/09/03 (US14/016,746)

(51) **Cl.Int./Int.Cl.** *F24H 9/20* (2006.01)

(72) **Inventeurs/Inventors:**

CHAUDHRY, RAHEEL A., US;
BOROS, JOZEF, US;
TURRIN, GIANPIERO, IT

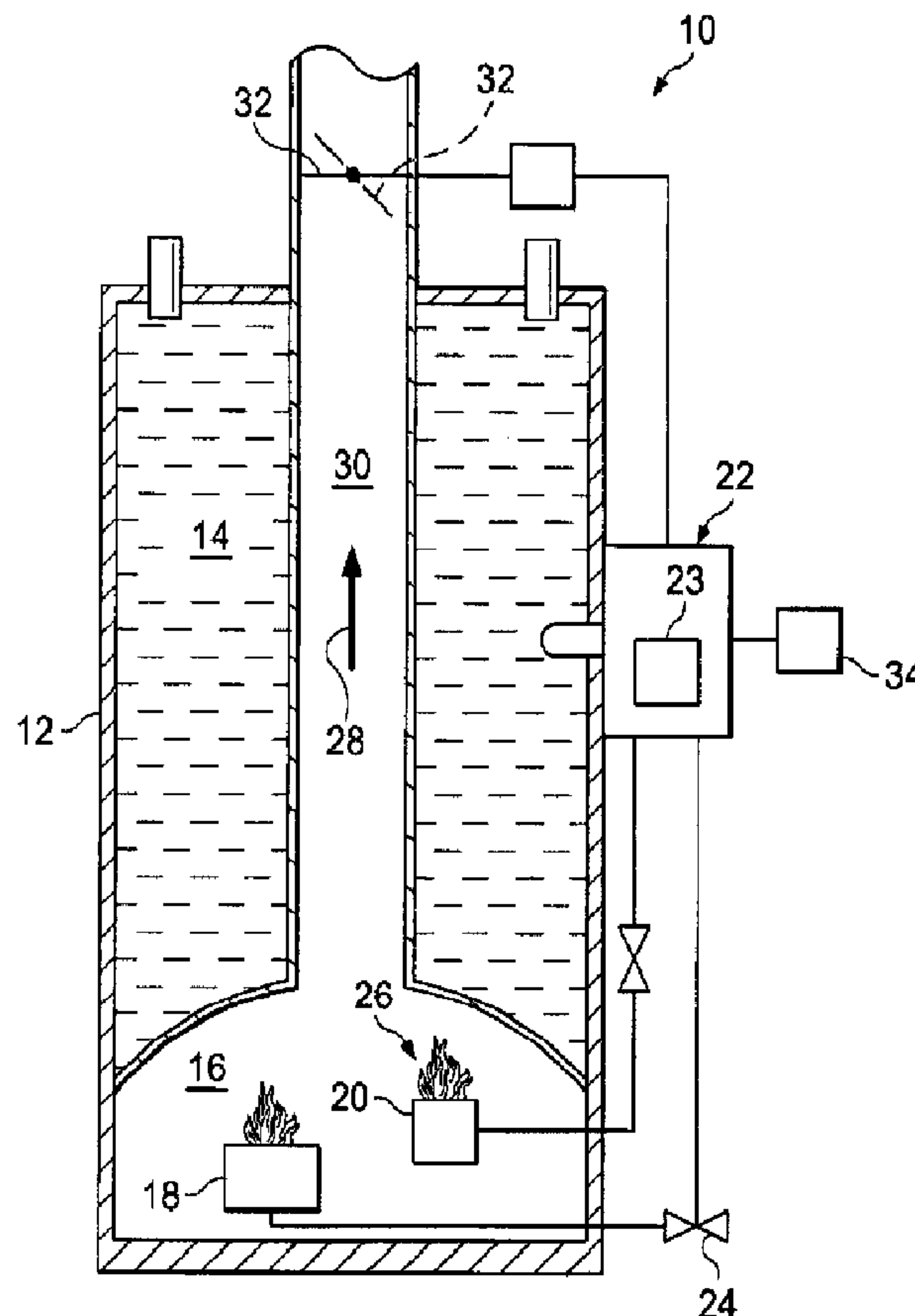
(73) **Propriétaire/Owner:**

RHEEM MANUFACTURING COMPANY, US

(74) **Agent:** BLAKE, CASSELS & GRAYDON LLP

(54) **Titre : ALGORITHME DE COMMANDE DE REGISTRE DE CARNEAU POUR CHAUFFE-EAU ALIMENTE PAR CARBURANT DE
TYPE A MISE EN ATTENTE DE LA SOUPAPE PILOTE**

(54) **Title: FLUE DAMPER CONTROL ALGORITHM FOR STANDING PILOT TYPE FUEL-FIRED WATER HEATER**



(57) **Abrégé/Abstract:**

In a fuel-fired water heater with a standing pilot burner and a motorized flue damper, a specially designed controller is utilized to prevent overheating of water stored in the tank portion of the water heater caused by the hot combustion gases continuously

(57) Abrégé(suite)/Abstract(continued):

generated by the pilot burner during standby periods of the water heater in which its main fuel burner is not being fired. The controller has a selectively variable water temperature control set point temperature and is operable to sense both ambient temperature and the tank water temperature and to open the flue damper and/or keep it open, after the main burner is off, in response to the presence for a predetermined continuous time period of a predetermined relationship of at least the selected temperature control set point temperature and the sensed ambient temperature.

ABSTRACT

In a fuel-fired water heater with a standing pilot burner and a motorized flue damper, a specially designed controller is utilized to prevent overheating of water stored in the tank portion of the water heater caused by the hot combustion gases continuously generated by the pilot burner during standby periods of the water heater in which its main fuel burner is not being fired. The controller has a selectively variable water temperature control set point temperature and is operable to sense both ambient temperature and the tank water temperature and to open the flue damper and/or keep it open, after the main burner is off, in response to the presence for a predetermined continuous time period of a predetermined relationship of at least the selected temperature control set point temperature and the sensed ambient temperature.

FLUE DAMPER CONTROL ALGORITHM FOR STANDING PILOT TYPE FUEL-FIRED WATER HEATER

BACKGROUND OF THE INVENTION

[0001] In a representatively illustrated embodiment thereof, this invention provides a standing pilot type fuel-fired water heater having incorporated therein a specially designed control algorithm which prevents overheating of water stored in the tank portion of the water heater during non-firing periods of the water heater's main burner.

[0002] Fuel-fired water heaters typically have a main fuel burner which is ignited by a smaller pilot burner in response to a sensed demand for heating water stored in a tank portion of the water heater. During "standby" periods of the water heater (when its main burner is not firing), a damper in the flue portion of the water heater is normally held in a closed position and opened upon a subsequent firing of the main burner.

[0003] When the water is provided with a "standing" pilot burner, whose flame burns continuously, the possibility exists that the tank water may be undesirably overheated by the hot combustion products continuously generated by the pilot burner. In view of this possibility, a need exists for control apparatus and methods for preventing such overheating. It is to this need that the present invention is primarily directed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 is a schematic illustration of a representative fuel-fired, standing pilot type water heater embodying principles of the present invention; and

[0005] FIG. 2 is a logic flow chart functionally illustrating a specially designed flue damper control algorithm operatively incorporated in the water heater.

DETAILED DESCRIPTION

[0006] Fuel-fired liquid heating apparatus is schematically depicted in FIG. 1 and is representatively a fuel-fired water heater 10, but could alternatively be another type of fuel-fired liquid heating apparatus, such as a boiler, without departing from principles of the present invention. Water heater 10 has the usual insulated tank 12 in which water 14 to be heated may be stored. Underlying the tank 12 is a combustion chamber 16 in which main and pilot burners

18,20 are disposed. Pilot burner 20 is a "standing" pilot burner which burns continuously and serves to ignite the main burner 18 when a controller 22 having a pre-programmed microprocessor 23 therein senses that the temperature of the water 14 is below a set point temperature of the controller 22 and responsively opens a main burner fuel supply valve 24. Fuel (representatively gas) supplied to the main burner 18 is then ignited by the standing pilot flame 26.

[0007] During standby periods of the water heater 10 (when the main burner 18 is not firing), the standing pilot burner flame 26 continues to create hot combustion gases 28 that rise through a flue 30 communicating with the combustion chamber 16, the flue 30 having a motor-driven damper 32 positioned in an upper end portion thereof for rotation between a solid line closed position and a dotted line open position. During water heater standby periods the damper 32 is normally motor-driven to and held in its solid line closed position in a suitable known manner by operation of the controller 22 which regulates the position of the damper 32.

[0008] Particularly when the ambient temperature externally adjacent the water heater 10 is at a high level, the potential exists for the hot standing pilot burner gases 28 to cause undesirable overheating of the tank water 14 when the water heater 10 is in a standby mode with the damper 32 closed. To combat this potential tank water overheating problem the controller 22 has a specially designed combination sensed water/ambient temperature-based damper control algorithm built into its microprocessor portion 23. In addition to operating the main burner 18 in the usual manner to maintain the tank water 14 at a predetermined set point temperature, the controller 22 senses excessive tank water temperature during standby periods and responsively opens the flue damper 32 to allow pilot burner flame combustion gases 28 to more readily escape through the flue and thereby prevent tank water overheating during water heater standby periods.

[0009] According to an aspect of the present invention, the controller 22, via a suitable temperature sensor 34, also monitors the ambient temperature externally adjacent the water heater 10 and transmits a sensed ambient temperature signal to the controller 22 which utilizes such signal, along with the sensed tank water temperature, in the previously mentioned algorithm to prevent overheating of the tank water 14 during standby periods of the water heater 10.

[0010] The functions of the combination water/ambient temperature-utilizing algorithm are depicted in the logic flow chart of FIG. 2 to which reference is now made. In the following description of the FIG. 2 algorithm, various illustrative numerical values and ranges are utilized for descriptive purposes. It is to be understood, however, that such values and ranges are utilized by way of non-limiting example only, and that other numerical values and ranges could be utilized if desired without departing from principles of the present invention.

[0011] Upon a start-up of the water heater 10 at step 40, at which a controller water temperature set point is selected, a transfer is made from step 40 to step 42 at which a query is made as to whether the selected set point is less than 110°F. If it is, a transfer is made to step 44 at which a temperature parameter $T_{\text{Threshold}}$ is set to 115°F and a transfer is made to step 46. If the query answer at step 42 is no, a transfer is made from step 42 to step 48 at which a query is made as to whether the selected set point is less than 130°F and greater than or equal to 110°F. If it is, a transfer is made to step 50 at which $T_{\text{Threshold}}$ is set to 120°F and a transfer is made to step 52. If the query answer at step 48 is negative, a transfer is made from step 48 to step 54 at which a query is made as to whether the selected set point is less than 140°F and greater than or equal to 130°F. If it is, a transfer is made to step 56 at which $T_{\text{Threshold}}$ is set to 125°F and a transfer is made to step 52.

[0012] If the query answer at step 54 is negative, a transfer is made from step 54 to step 58 at which a query is made as to whether the selected set point is greater than or equal to 140°F. If it is, a transfer is made to step 60 at which $T_{\text{Threshold}}$ is set to 130°F. When the query answer at step 58 is negative a transfer is also made to step 52.

[0013] If the selected set point temperature is less than 110°F, the algorithm has transferred to step 46 and operates to monitor the ambient temperature $T_{\text{Amb.}}$ and responsively control the damper 32 to prevent overheating of the tank water 14. Specifically, at step 46 a query is made as to whether $T_{\text{Amb.}}$ has been greater than $T_{\text{Threshold}}$ continuously for at least a predetermined time (for example, five minutes) as measured by a clock portion of the controller 22. If the query answer at step 46 is yes, a transfer is made to step 62 at which the damper 32 is opened if the transfer to step 62 occurs during a standby period during which the damper 32 is closed, or the damper 32 is kept open after the main burner 18 is shut down to initiate a standby period. On the other hand, if the query answer at step 46 is no, a transfer is made from step 46 to step 64 at which the damper 32 is closed if open during a standby period, or kept closed after main burner shutdown initiates a standby period.

[0014] After a transfer is made from step 46 to step 62 or step 64, the clock is reset, and the ambient/threshold temperature-based monitoring is continued at step 46 which may subsequently switch the damper control from step 62 to step 64, or from step 64 to step 62, as necessary depending on the sensed ambient temperature and elapsed clock time.

[0015] If the selected set point temperature is such that a transfer has been made to step 52 (via step 48, 54 or 58), the algorithm operates to monitor both the ambient temperature T_{Amb} and the tank water temperature T_{Tank} and responsively control the damper 32 to prevent overheating of the tank water 14. A query is made at step 52 as to whether both the sensed ambient temperature T_{Amb} and sensed tank water temperature T_{Tank} have been greater than $T_{Threshold}$ continuously for at least a predetermined time as measured by the clock portion of the controller 32. If this query answer is yes, a transfer is made from step 52 to step 62 at which the damper 32 is opened if the transfer to step 62 occurs during a standby period during which the damper 32 is closed, or the damper 32 is kept open after the main burner 18 is shut down to initiate a standby period. On the other hand, if the query answer at step 52 is no, a transfer is made from step 52 to step 64 at which the damper 32 is closed if open during a standby period, or kept closed after main burner shutdown initiates a standby period.

[0016] After a transfer is made from step 52 to step 62 or step 64, the clock is reset, and the ambient/tank water/threshold temperature-based monitoring is continued at step 52 which may subsequently switch the damper control from step 62 to step 64, or from step 64 to step 62, as necessary depending on the sensed ambient temperature, tank water temperature and elapsed clock time.

[0017] As can be seen from the foregoing, the present invention uniquely provides for the control of a flue damper in a standing pilot type fuel-fired water heater based on various combinations of selected water heater set point temperature, sensed ambient temperature and sensed tank water temperature to prevent overheating of the water heater tank water during standby periods of the water heater.

[0018] The foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the scope of the present invention being limited solely by the appended claims.

WHAT IS CLAIMED IS:

1. Fuel-fired liquid heating apparatus comprising:
 - a tank adapted to hold a quantity of liquid to be heated;
 - a combustion chamber adjacent said tank;
 - a flue communicating with said combustion chamber and extending through said tank;
 - a damper structure disposed within said flue for controlled movement between open and closed positions;
 - a main fuel burner operative to discharge hot combustion products through said flue to heat liquid within said tank;
 - a standing pilot type fuel burner that discharges hot combustion products into said flue during standby periods of said fuel-fired liquid heating apparatus when said main burner is not firing; and
 - control apparatus having a selectively variable liquid temperature control set point temperature and having a temperature threshold parameter different than and based on the liquid temperature control set point temperature, said control apparatus also being operable to sense both ambient temperature and the temperature of liquid in said tank, said control apparatus being arranged to open said damper or keep it in an open position, after said main burner is off, when the sensed ambient temperature is above the temperature threshold parameter for a measureable, predetermined continuous time period to prevent overheating of the tank liquid by said standing pilot type fuel burner during standby periods of said fuel-fired heating apparatus.
2. The fuel-fired liquid heating apparatus of Claim 1 wherein:
 - said control apparatus is further operable to close said damper or keep it in a closed position, after said main burner is off, when the sensed ambient temperature is below the temperature threshold parameter.
3. The fuel-fired liquid heating apparatus of Claim 1 wherein:
 - the liquid temperature control set point temperature is a first liquid temperature control set point temperature, and the temperature threshold parameter is a first temperature threshold parameter;

said control apparatus is further operable to open said damper or keep it in said open position, after said main burner is off, when the sensed temperature of liquid in the tank is above a second liquid temperature control set point temperature, and the sensed ambient temperature is above a second temperature threshold parameter that is different than and based on the second liquid temperature control set point temperature for a measurable, predetermined continuous time period, to prevent overheating of the tank liquid by said standing pilot type fuel burner during standby periods of said fuel-fired heating apparatus.

4. The fuel-fired liquid heating apparatus of Claim 3 wherein:

said second selected temperature control set point temperature is greater than said first selected temperature control set point temperature.

5. The fuel-fired liquid heating apparatus of Claim 2 wherein:

said control apparatus is further operable to close said damper or keep it in said closed position, after said main burner is off, when the sensed temperature of liquid in the tank is not above the temperature threshold parameter to prevent overheating of the tank liquid by said standing pilot type fuel burner during standby periods of said fuel-fired heating apparatus.

6. The fuel-fired liquid heating apparatus of Claim 5 wherein:

said temperature threshold parameter is greater than said selected temperature control set point temperature.

7. The fuel-fired liquid heating apparatus of Claim 3 wherein:

said control apparatus is further operative to generate the first temperature threshold parameter to be greater than said first selected temperature control set point temperature, and to generate the second temperature threshold parameter to be less than said second selected temperature control set point temperature.

8. The fuel-fired liquid heating apparatus of Claim 5 wherein:

said control apparatus is further operative to generate the first temperature threshold parameter to be greater than said first selected temperature control set point temperature, and to generate the second temperature threshold parameter to be less than said second selected temperature control set point temperature.

9. A fuel-fired water heater comprising:

a tank adapted to hold a quantity of water to be heated;

a combustion chamber adjacent said tank;

a flue communicating with said combustion chamber and extending through said tank;

a damper structure disposed within said flue for controlled movement between open and closed positions;

a main fuel burner operative to discharge hot combustion products through said flue to heat water within said tank;

a standing pilot type fuel burner that discharges hot combustion products into said flue during standby periods of said fuel-fired liquid heating apparatus when said main burner is not firing; and

control apparatus having a selectively variable water temperature control set point temperature, a first temperature threshold parameter, and a second temperature threshold parameter, said control apparatus also being operable to sense both ambient temperature and the temperature of water in said tank, said control apparatus being further operable to:

(1) open said damper or keep it in said open position, after said main burner is off, when the sensed ambient temperature is above the first temperature threshold parameter for a measurable, predetermined continuous time period to prevent overheating of the tank water by said standing pilot type fuel burner during standby periods of said fuel-fired water heater, and to close said damper or keep it in said closed position, after said main burner is off, when the sensed ambient temperature is below the first temperature threshold parameter, and

(2) open said damper or keep it in said open position, after said main burner is off, when the sensed temperature of liquid in the tank is above a second liquid temperature control set point temperature that is greater than the first liquid temperature control set point temperature and the sensed ambient temperature is above the second temperature threshold parameter for a measurable, predetermined continuous time period to prevent overheating of the tank water by said standing pilot type fuel burner during standby periods of said fuel-fired

water heater, and to close said damper or keep it in said closed position, after said main burner is off, when the sensed ambient temperature is below the second temperature threshold parameter or the sensed temperature of liquid in the tank is below the second liquid temperature control set point temperature.

10. The fuel-fired water heater of Claim 9 wherein:

said control apparatus is further operative to generate the first temperature threshold parameter having a magnitude related in a predetermined manner to said first selected temperature control set point temperature, and to generate the second temperature threshold parameter having a magnitude related in a predetermined manner to said second selected temperature control set point temperature.

11. For use in conjunction with a fuel-fired water heater disposed in a location having an ambient temperature, said fuel-fired water heater having a tank adapted to hold a quantity of water to be heated, a combustion chamber adjacent said tank, a flue communicating with said combustion chamber and extending through said tank, a damper structure disposed within said flue for controlled movement between open and closed positions, a main fuel burner operative to discharge hot combustion products through said flue to heat water within said tank, a standing pilot type fuel burner that discharges hot combustion products into said flue during standby periods of said fuel-fired water heater when said main burner is not firing, and a selectively variable water temperature control set point, a method of preventing said standing pilot type fuel burner from overheating the tank water during standby periods of said fuel-fired water heater, said method comprising the steps of:

determining a temperature threshold parameter different than and based on the water temperature control set point;

sensing the ambient temperature;

opening said damper or keeping it in said open position, after said main burner is off, when the sensed ambient temperature is above the temperature threshold parameter for a measurable, predetermined continuous time period to prevent overheating of the tank water by said standing pilot type fuel burner during standby periods of said fuel-fired water heater, and

closing said damper or keeping it in said closed position, after said main burner is off, when the sensed ambient temperature is below the temperature threshold parameter.

12. The method of Claim 11 comprising:

sensing the tank water temperature;

opening said damper or keeping it in said open position, after said main burner is off, when the sensed temperature of liquid in the tank is above a second liquid temperature control set point temperature that is greater than the first liquid temperature control set point temperature and the sensed ambient temperature is above the second temperature threshold parameter for a measurable, predetermined continuous time period to prevent overheating of the tank water by said standing pilot type fuel burner during standby periods of said fuel-fired water heater, and

closing said damper or keeping it in said closed position, after said main burner is off, when the sensed ambient temperature is below the second temperature threshold parameter or the sensed temperature of liquid in the tank is below the second liquid temperature control set point temperature.

13. For use in conjunction with a fuel-fired water heater disposed in a location having an ambient temperature, said fuel-fired water heater having a tank adapted to hold a quantity of water to be heated, a combustion chamber adjacent said tank, a flue communicating with said combustion chamber and extending through said tank, a damper structure disposed within said flue for controlled movement between open and closed positions, a main fuel burner operative to discharge hot combustion products through said flue to heat water within said tank, a standing pilot type fuel burner that discharges hot combustion products into said flue during standby periods of said fuel-fired water heater when said main burner is not firing, and a selectively variable water temperature control set point, a method of preventing said standing pilot type fuel burner from overheating the tank water during standby periods of said fuel-fired water heater, said method comprising the steps of:

determining a temperature threshold parameter different than and based on the water temperature control set point;

sensing the ambient temperature

sensing the tank water temperature;

opening said damper or keeping it in said open position, after said main burner is off, when the sensed temperature of liquid in the tank is above a second liquid temperature control set point temperature that is greater than the first liquid temperature control set point temperature and the sensed ambient temperature is above the second temperature threshold

parameter for a measurable, predetermined continuous time period to prevent overheating of the tank water by said standing pilot type fuel burner during standby periods of said fuel-fired water heater, and

closing said damper or keeping it in said closed position, after said main burner is off, when the sensed ambient temperature is below the second temperature threshold parameter or the sensed temperature of liquid in the tank is below the second liquid temperature control set point temperature.

1/2

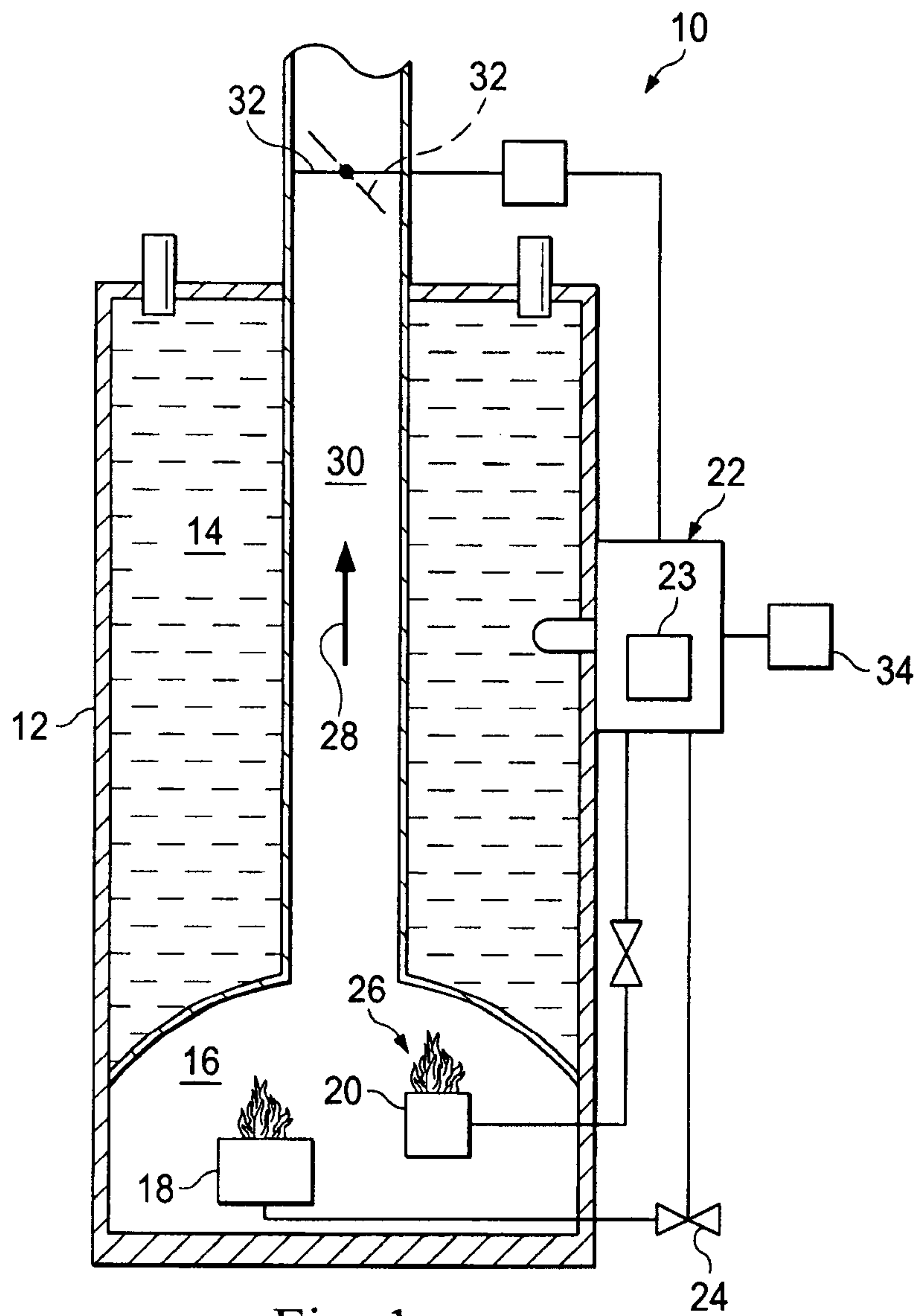


Fig. 1

2/2

Fig. 2

