

[54] SINGLE UNIT AIR-WATER HEATING APPLIANCE

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[51] Int. Cl. F24h 6/00

[58] Field of Search 237/19; 126/101; 165/179; 236/9 R

[56]

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[57]

ABSTRACT

A single unit heating appliance comprising an air plenum and a water heating container with a heat exchanger extending into the plenum is shown. Water is heated by a burner and some of its heat is transferred to the heat exchanger which transfers the heat to ambient air passing thereover.

4 Claims, 4 Drawing Figures

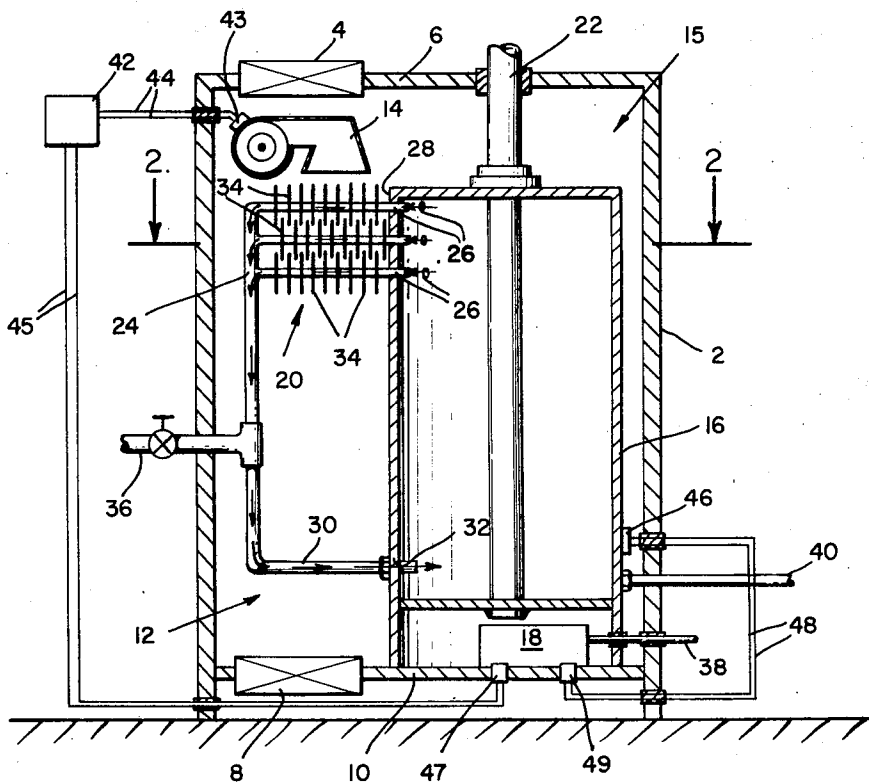


Fig. 1.

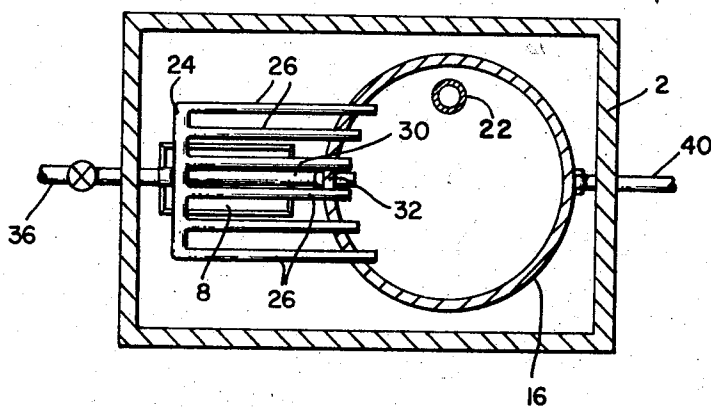
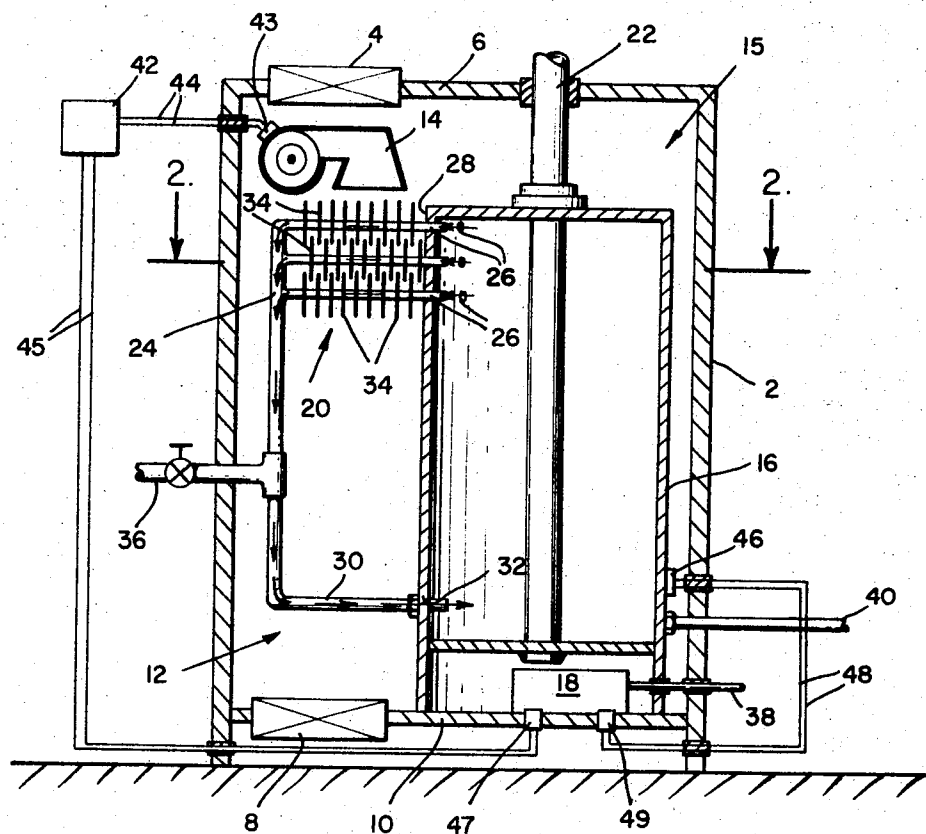


Fig. 2.

Fig. 3.

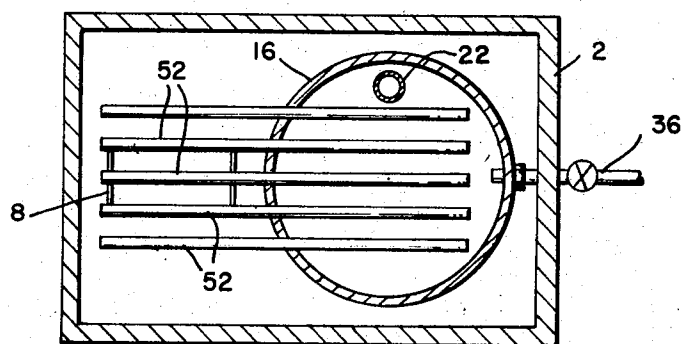
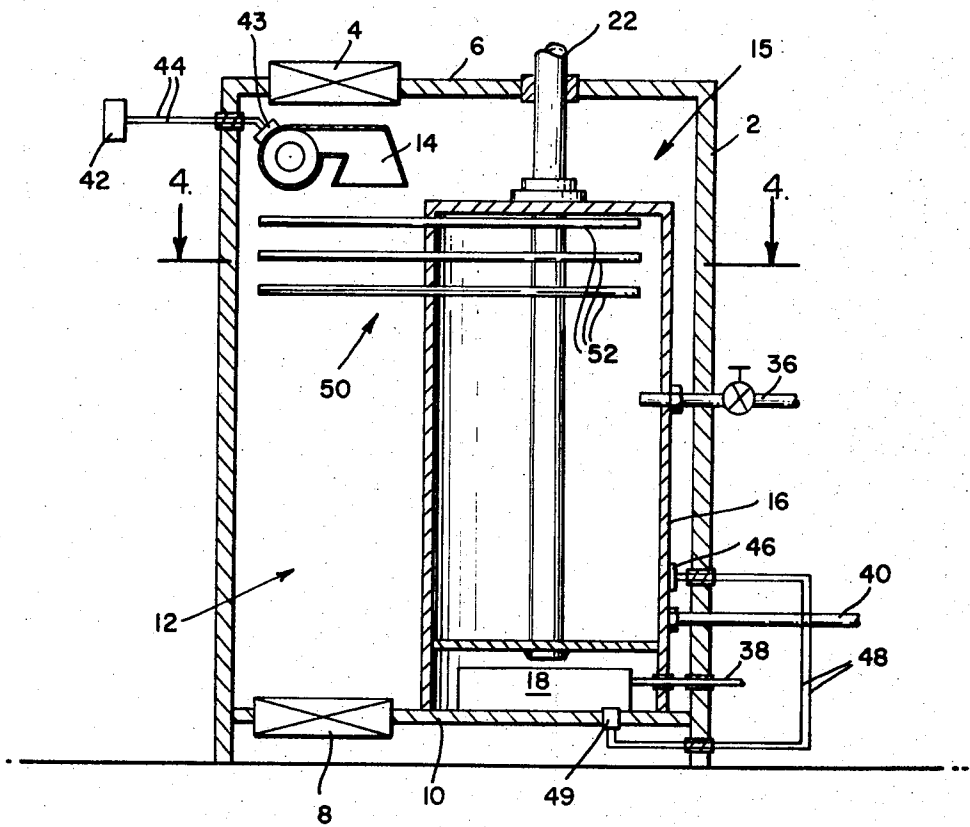


Fig. 4.

SINGLE UNIT AIR-WATER HEATING APPLIANCE

This invention relates generally to air and water heaters, and more specifically to single unit air-water heating appliances which use hot water in conjunction with a heat exchanger to heat ambient air in residential quarters. The single unit air-water heating appliance of this invention is referred to herein and in the claims as a hydro-furnace.

Heating systems for use in residential and mobile homes abound in the art and are varied in form. For example, there are warm air furnaces, forced air furnaces, fuel burning furnaces, space heaters, combination air and water heaters, to name a few. In the case of simple air heaters, the cold air is usually passed through a fuel-burning furnace and forced out into ducts which direct the warm air to various parts of the house. Dust particles in the air are charred as they pass through the furnace, causing air contamination and creating a buildup of soot on the air registers and ceilings. Space heaters are designed to heat only the space or room in which they are situated, consequently, a heater is required for each room in a house. Combination air and water heaters usually heat cold air by having the air pass over the hot water container or by passing the cold air through or over the hot water furnace or both. Independent control of the heating of the air and of the water is not available in such systems.

A specific example of the prior art is a patent by K. M. Ronan et al., entitled "Combination Water and Space Heater," U.S. Pat. No. 3,269,382. Therein Ronan shows a potable water container above a fuel burning furnace with a passage therebetween. The air is heated by first passing over the potable water container and then through the aforementioned passage. Aside from the fact that this is a space heater and is therefore limited in use, it has the further disadvantage that the water furnace controls the heating of the air. When the temperature of the potable water is at its required value, the furnace turns off and the heat supplied to the air is diminished to the heat available from the surface of the hot water container as the air passes over it. This is the case regardless of the temperature of the air in the room being heated, because the room temperature does not control the water furnace. This is true of all heating systems which heat air by means of the water furnace. In a forced air system this could result in cold air filling a cold room, thereby providing an undesired effect.

Another specific example of the prior art is described in a patent by J. R. Piper, entitled "Heating System," U.S. Pat. No. 3,526,361. Piper uses the potable hot water as the heat source for heating the air by circulating the hot water through a series of heat exchange coils, one in each room to be heated and passing the cool air over the heat exchanger. The various heat exchangers are connected in series and the hot water is circulated continuously by a water pump. A thermostat in each room controls the hot air flow and a thermostat on the water container controls the water furnace.

While Piper provides a flow of clean hot air to each room as well as independent thermostatic control of the water furnace and the air heating, nevertheless, this system has certain disadvantages. Such a heating system must be installed during the construction of the building so that the plumbing can be built into each room. To install this system into an existing house, if

possible, would require excessive carpentry because the walls and/or ceilings would have to be broken into and subsequently repaired. The materials required would be expensive because of the extensive insulated plumbing needed, the large water pump required to circulate the water through so much plumbing, and the number of heat exchangers, blowers and thermostats employed. Nor can the system be removed easily or inexpensively since it is integrally constructed as part of the house.

A further disadvantage of Piper's system is that no provision is made for air heating during the time a depleted hot water supply is being reheated. Regardless of its temperature, the water in the water tank is constantly circulated throughout the system. Thus, when cold water is present, such as after someone has taken a long hot shower, the air is being blown over cold heat exchangers. The air being forced through Piper's registers is therefore cold at this time and will remain cold until the water is reheated. The reheating of the water occurs gradually over a period of perhaps several hours, leaving the residents without heat.

There exists today a need for a single self-contained inexpensive heating appliance which can heat a supply of potable water as well as cold air and control each independently of the other and simultaneously avoid contamination of the air. Such a unit would be safer than conventional furnaces and could be made to furnish all necessary heat to a home in conjunction with ducts of a central heating plan, and particularly to heat mobile homes where space is scarce. It would be desirable to have a unit which uses the hot potable water to heat the air and which circulates the water without using a water pump. This would eliminate an expense as well as reduce the number of moving parts. It would also be desirable to have a unit which can supply heated air during the reheating of a depleted hot water supply within minutes after depletion.

Accordingly, it is an object of this invention to provide a self-contained home heating appliance for heating air and potable water.

It is another object of the present invention to provide a combination air-water heating appliance wherein independent thermostatic control over the air heating and over the water heating is maintained.

A further object of this invention is to provide a combination air-water heating appliance wherein the hot water is used to heat the air.

Yet another object of the present invention is to provide a single unit combination air-water heating appliance which can function without a water pump.

Still another object of this invention is to provide a single unit combination air-water heating appliance which supplies heated air during the reheating of a depleted hot water supply.

These and other objects and advantages of this invention are accomplished by a hydro-furnace for heating potable water directly and air indirectly and maintaining continuous independent control over both. The hydro-furnace comprises a housing having a return register, a supply register, and a plenum therebetween. Within the housing is disposed a water heating container having a water storage tank, a cold water inlet, a hot water outlet, a flue which extends through the housing, and a heating mechanism, such as a burner, for heating the potable water. Disposed within the plenum is a blower for drawing ambient air through the

return register and blowing it through the plenum and toward the supply register. A control mechanism, such as a thermostat, is associated with both the blower and the heating mechanism and turns them on and off. Associated with the water heater is a heat exchanging mechanism, such as a finned-tube manifold or a set of heat-conducting members, which extends from the tank into the plenum and which transfers heat from the hot water to the air in the plenum.

The invention will be described in greater detail in conjunction with the accompanying drawings in which:

FIG. 1 is a cross-sectional elevational view of the hydro-furnace according to one embodiment of the invention;

FIG. 2 is a cross-sectional view of the hydro-furnace of FIG. 1 taken through section 2—2;

FIG. 3 is a cross-sectional elevational view of the hydro-furnace according to another embodiment of this invention; and

FIG. 4 is a cross-sectional view of the hydro-furnace of FIG. 3 taken through section 4—4.

Referring now to FIGS. 1 and 2, there is shown an embodiment of the hydro-furnace of this invention comprising a housing 2 having a return register 4 disposed in one end 6 thereof and a supply register 8 disposed in an opposite end 10 thereof, the space therebetween defining an air plenum 12. A blower 14 is disposed within the housing 2 and adjacent the return register 4 such that it can draw ambient air through the return register 4 and blow it through the plenum 12 and toward the supply register 8.

A hot water heating container 15 is disposed within the housing 2 adjacent the plenum 12 and comprises a water storage tank 16, a fuel burner 18, a finned-tube heat exchanger 20, and a flue 22. The heat exchanger 20 is disposed within the plenum 12 and comprises a manifold water pipe 24 having several parallel lateral pipes 26 connected to the upper end 28 of the tank 16 and a return pipe 30 connected to the lower end 32 of the tank 16. The burner 18 is disposed beneath the tank 16 and away from the return pipe 30. Several parallel heat-conducting fins 34 are attached perpendicularly to the pipes 26, and a hot water outlet line 36 for furnishing potable hot water to various hot water faucets is connected to the return pipe 30. A fuel supply line 38 is provided for supplying fuel to the burner 18, and a cold water supply line 40 is provided for furnishing potable water to the tank 16.

A thermostat 42 located within the living quarters to be heated controls an on-off switch 43 on the blower 14 and is coupled thereto by electrical wires 44. The blower 14 is turned on and off as the ambient temperature varies below and above a preselected level, respectively. The burner 18 is thermostatically controlled by another thermostat 46 which senses the water temperature at the lower end 32 of the tank 16. Wires 48 couple thermostat 46 to a valve 49 on the burner 18. The water temperature is maintained within a sufficiently hot range such as between 140° and 150° F, for example. Thus, when the temperature of the water falls below 140° F, the valve 49 is opened and the burner 18 is turned on, and when the temperature reaches 150° F, the valve 49 is closed and the burner 18 is turned off. The thermostats 42 and 46 work independently of one another.

The thermostat 46 is placed at the lower end 32 of the tank 16 to ensure that all the water in the tank 16 is heated to the desired temperature. As the water is heated, it rises to the top in accordance with a well known heat transfer principle of physics referred to as convection. The water molecules nearest the burner 18 are heated and expand due to an increased temperature. These water molecules are lighter than the colder ones above, therefore they rise and displace the colder ones which descend. If the thermostat 46 were to be placed at the upper end 28 of the tank 16, it would sense the desired temperature of 150° F at that point while the temperature at the lower end 32 would be perhaps 120° F or lower. The burner 14 would then shut off before all the water would have been heated, thus defeating the purpose of achieving the desired temperature throughout the tank 16.

The operation of the hydro-furnace of this invention is best understood by first considering the steady state condition wherein the water in the tank 16 is between 140° and 150° F. As the ambient air goes below the desired room temperature, the blower 14 turns on and blows air across the fins 34 of the heat exchanger 20. Heat from the hot water in the pipes 26 is transferred via the fins 34 to the air, which is warmed thereby, and the water in the heat exchanger 20 is cooled. Ultimately a sufficient amount of cold water will accumulate in the lower end 32 of the tank 16 to lower the temperature at the thermostat 46 below 140° F. At this point, the burner 18 turns on to reheat the water. The heated water rises, enters the heat exchanger 20, is cooled, flows down the return pipe 30, and re-enters the tank 16 where it is reheated. A convection current is thereby established which continuously provides hot water to the heat exchanger 20. This is accomplished notably without the aid of a pump.

It is preferable to have the convection current established as soon as the blower 14 is turned on. This can be accomplished with a two-stage burner 18 wherein the thermostat 42, in addition to controlling the switch 43 on the blower 14, is coupled via wires 45 to a valve 47 which controls the first stage of the burner 18. Thus, when the blower 14 is turned on, the valve 47 is opened and the first stage of the burner 18 is turned on simultaneously. The controls could be arranged so that thermostats 42 and 46 control the first and second stages, respectively, or alternatively, that thermostat 46 controls both stages when the blower 14 is off and only the second stage when the blower 14 is on. Either arrangement is compatible with this invention.

The heat generated by the first stage of the burner 18 should be at least sufficient to establish the aforementioned convection current. The second stage of the burner 18 should supply sufficient heat to reheat the water to the desired temperature (for example, 150° F) and would be controlled by the thermostat 46.

Various other two-stage burners, such as electric or oil burners for example, may also be satisfactory if otherwise compatible with the teachings herein.

When a hot water faucet is opened, hot water will be drawn from the outlet line 36, which is connected to the return pipe 30. The temperature of the water drawn will be lower than that of the water in the tank 16 because of the transfer of heat from the water to the air blown across the heat exchanger 20. However, the rate of flow of hot water through the heat exchanger 20 is increased when the hot water faucets are opened,

therefore, the temperature of the water in the return pipe 30 when hot water is being drawn is significantly higher than when no hot water is drawn. Thus, a supply of potable hot water at a sufficiently hot temperature is assured so long as there is hot water in the tank 16.

As hot water is drawn, cold water enters the tank 16 to maintain a constant volume. When sufficient amounts of hot water are drawn, the water temperature sensed by the thermostat 46 will be low enough to turn on the burner 18, and in the case of a two-stage burner, the second stage. However, if great amounts of hot water are drawn, as is possible if two showers are in use simultaneously, for example, the water in the tank 16 may have a temperature only slightly higher than the cold water entering. The hot water supply is then said to be exhausted and cannot be replenished while the hot water faucets are open and drawing water.

The time required to reheat the water to the desired temperature of, for example, 150° F is referred to as the recovery time and is measured from the time the hot water faucets are closed. Heat is supplied by the burner 18 which heats the water in the tank 16. Throughout the recovery time, heat is available to warm the air blowing past the heat exchanger 20 because of the convection current previously discussed. The hot water rises to the top of the tank 16 and goes into the heat exchanger 20. In a matter of minutes, the water in the heat exchanger 20 will be sufficiently hot to warm the air. For a 30-gallon water heater with a heat capacity of 76,200 BTU and for a blower with an air flow rate of 600 cubic feet per minute (cfm), for example, it will take on the order of 1½ hours to reheat all the water in the tank 16 to the desired 150° F. This recovery time will be approximately ½ hour when the blower 14 is off because then no heat is transferred from the water to the air. These times are substantially less than the recovery times of 4 hours and 1½ hours, respectively, required by Ronan. They are also substantially less than the average recovery times for conventional 30-gallon water heaters currently on the market.

The burner 18 is set away from the return pipe 30 in FIG. 1 and made smaller in diameter than the tank 16 in FIG. 3 in order to prevent hot water from travelling up through the return pipe 30. The hot water molecules tend to rise, as discussed previously. Therefore, by providing lateral space between the burner 18 and the return pipe 30 in this way, the hot water would first have to travel laterally to get to the pipe 30. Since the hot water tends to rise, it will do so rather than move laterally. The circulating convection current is thereby enhanced, and the heated water will rise and reach the heat exchanger 20 within seconds. This ensures that the air will be heated even though the hot water supply is exhausted.

In FIGS. 3 and 4 there is shown another embodiment of the hydro-furnace of this invention which is distinguishable from the hydro-furnace of FIGS. 1 and 2 in that the finned-tube heat exchanger 20 is replaced by another type of heat exchanger 50 comprising multiple lateral heat conducting members 52, such as rods or tubes, extending from within the tank 16 to the plenum 12. This embodiment dispenses with the circulating convection current of the first embodiment and, therefore, with the return pipe 30 as well. The heat from the hot water in the tank 16 is conducted by the members

52 to the plenum 12 where it is transferred to the air blown by the blower 14.

The recovery times for the embodiment of FIG. 3 are essentially the same as for that of FIG. 1. The members 52 experience a temperature gradient caused by the cool air in the plenum 12 and, therefore, attract heat from the hot water rising in the tank 16 and conduct the heat to the plenum 12 where it is promptly transferred to the air. When the members 52 are tubes, they may be filled with a liquid under a pressure such that the liquid boils at the desired hot water temperature. The liquid would then be partially vaporized and a steady state would exist in the tube member 52 such that the temperature gradient in the tube member 52 would be insignificant. The transfer of heat from the hot water to the air in the plenum 12 would be facilitated thereby.

Fins 34 may be used in conjunction with members 52, if desired, to further aid in transferring heat from the members 52 to the air in the plenum 12. The hot water outlet line 36 may be connected to the water storage tank 16 at any convenient location in this embodiment, and preferably near the top, as shown. The burner 18 may be a single stage or double stage variety, as in the first embodiment, and is positioned conveniently beneath the tank 16.

Installation of the hydro-furnace taught by this invention is relatively easy since it is a self-contained unit. A separate furnace and water heater are no longer required when the hydro-furnace is used, therefore, a substantial space savings is achieved, particularly in mobile homes where space is very limited.

There has thus been shown and described a single unit heating appliance for heating potable water directly and air indirectly and maintaining continuous independent control over both. Although specific embodiments of the invention have been described in detail, other variations of the embodiments shown may be made within the spirit, scope and contemplation of the invention.

Accordingly, it is intended that the foregoing disclosure and drawings shall be considered only as illustrations of the principles of this invention and are not to be construed in a limiting sense.

What is claimed is:

1. A hydro-furnace for heating potable water directly and air indirectly and maintaining continuous independent control over both, comprising:

a housing having a return register, a supply register, and a plenum therebetween;

a water heating container disposed within said housing having a water storage tank, a cold water inlet, a hot water outlet, a flue extending through said housing, and a burner disposed beneath said tank for heating said potable water;

blower means disposed in said plenum for drawing ambient air through said return register and blowing said air through said plenum and toward said supply register;

control means associated with said blower and said burner for switching said blower and said burner on and off, said control means comprising a first thermostat responsive to room temperatures and coupled to said blower, and a second thermostat responsive to the temperatures in said tank and coupled to said burner, said thermostats functioning electrically independently of one another; and

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heat exchanging means associated with said water storage tank and extending into said plenum for transferring heat from said hot water to said air in said plenum.

2. The hydro-furnace claimed in claim 1 wherein: said burner includes a first stage coupled to said first thermostat, said first stage and said blower means being switched on and off essentially simultaneously by said first thermostat, and a second stage coupled to said second thermostat, said first and second stages functioning independently of one another; and

said heat exchanging means includes multiple lateral

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pipes coupled to the upper end of said tank at one end and to a manifold pipe at the other, said manifold pipe being coupled to a return pipe which is coupled to the lower end of said tank, said hot water circulating therethrough.

3. The hydro-furnace claimed in claim 2 wherein said burner is further disposed away from said return pipe.

4. The hydro-furnace claimed in claim 1 wherein said heat exchanging means includes multiple lateral heat-conducting rods attached to the upper end of, and extending into said tank.

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