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S. BOGREN

3,033,192

AIR AND WATER HEATING DEVICES

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2 Sheets-Sheet 1

FIG. 1

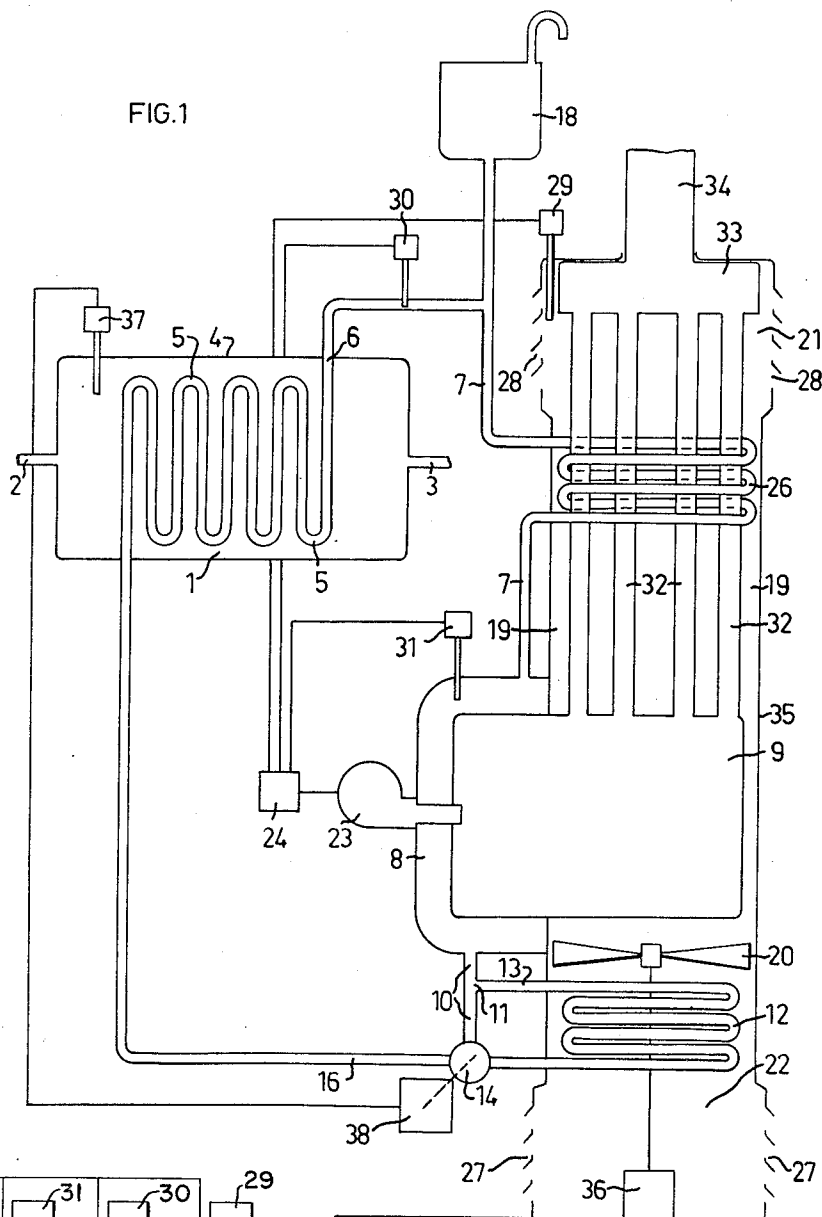
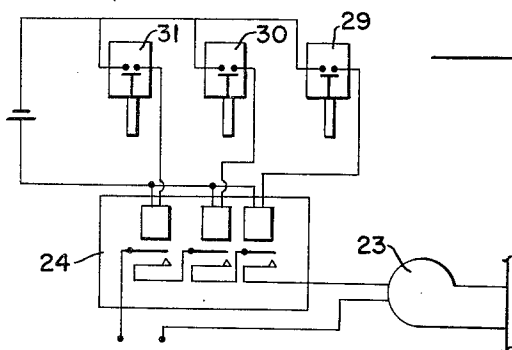


FIG. 3



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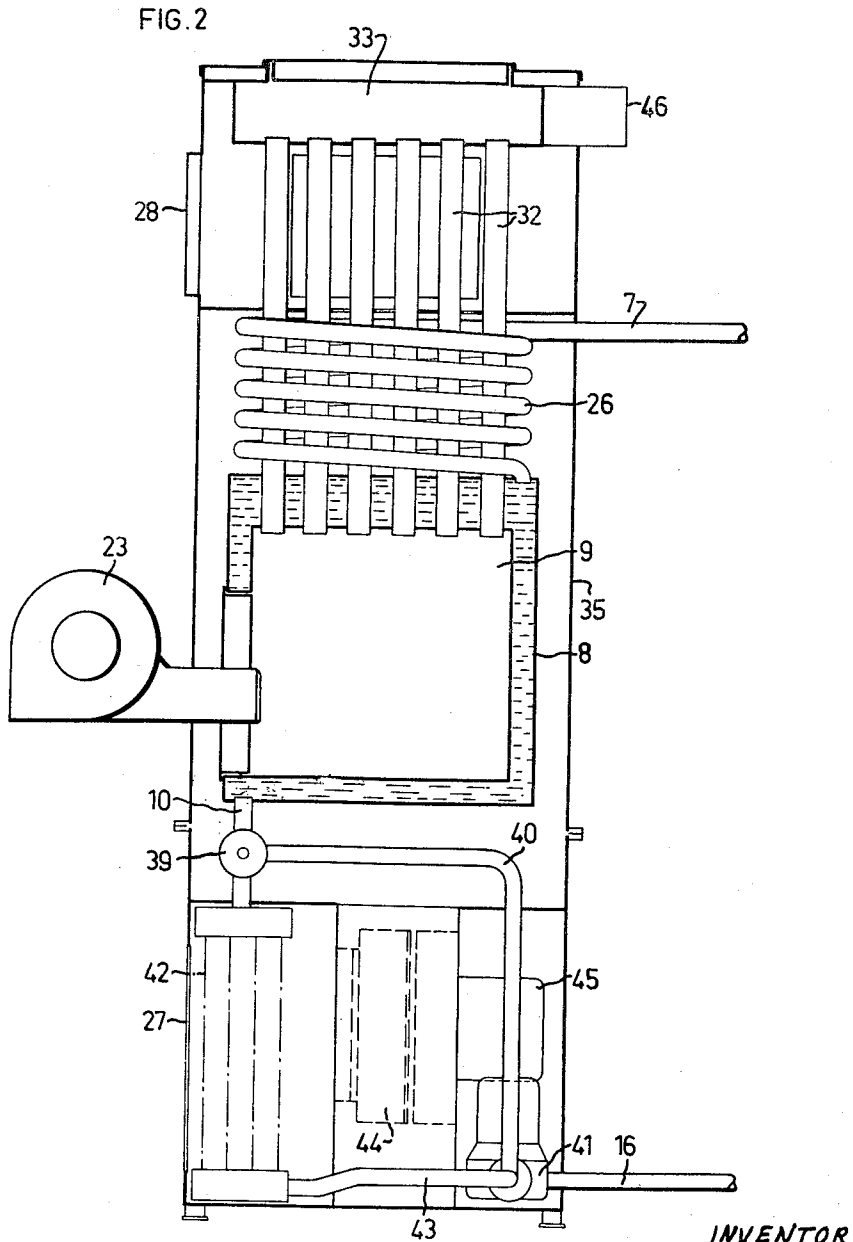
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AIR AND WATER HEATING DEVICES

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3 Claims. (Cl. 126—101)

Devices for heating premises by means of hot air are previously known and exist in many different forms and sizes. Such devices become more and more usual by reason of their many advantages over most heating devices of other types. Among these advantages there may be mentioned primarily the speed at which the air is heated to a temperature comfortable to the persons in the premises also when the original temperature was extremely low. The costs of installing the heating apparatus also are very low as compared with those of other ordinary heating installations, for example such where water is used as a heat transfer medium.

However, the last-mentioned type of heating installations have had until now certain advantages over the air heating installations. These advantages include the ease of combining room heating devices with devices for water heating, and the greater uniformity of temperature that characterizes such devices. In the last-mentioned respect, however, this may sometimes be a disadvantage, for example when the premises are exposed from time to time to substantial changes of air, such as for instance in certain public, workshop and like premises. In such case heating by means of an air heater may sometimes be preferable, as the air temperature can then be raised more rapidly to a suitable level. Often, however, where there is a need of hot water the heating installation is designed as a water heating system although such a system will provide a less satisfactory heating of the premises.

Devices for air heating have not hitherto permitted suitable combinations with devices for water heating. Where there is a need for hot water one has therefore been forced either to renounce from the advantages of the air heating and to put up with the disadvantages associated with a more expensive system, or one has installed a separate water heater as well as an air heater. Quite naturally this involves higher costs than if it had been possible to obtain a device for a rapid heating of the premises and at the same time an efficient water heater.

The present invention has for its object to provide a device which combines the advantage of a rapid heating of the air in the premises and that of a likewise rapid, efficient and cheap water heating, and which, if need be, can be operated either as an air heater or as a water heater. The device according to the invention is characterized by the fact that a source of heat is provided for a common heating of the air in an air heater and the water in a water heater which is connected to a closed water system comprising one or more means disposed in the air passageways of the air heater and suited for taking up and giving off heat, such as tube coils, at least one of which is placed in the cold air zone of the air heater and adapted to be shut off from, or brought in, communication with the other portions of the closed water system by means of a valve automatically operated in dependence on the temperature of the water heater.

The invention will be described more in detail with reference to the accompanying drawings in which:

FIG. 1 diagrammatically shows an embodiment of a system according to the invention;

FIG. 2 shows another embodiment thereof; and

FIG. 3 is a circuit diagram of the thermostat controls for the system.

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In the embodiment shown in FIG. 1, a water heater 1 of a known type has an outer tank 4 connected to an inlet pipe 2 and an outlet pipe 3. The inlet pipe 2 is connected to a cold water conduit. Disposed in the tank 4 is a heating coil 5 of tubes which constitute part of a closed circulating system for water. One end 6 of the tube coil 5 is connected to a pipe 7 coming from a container 8. This pipe is in the form of a coil 26 the location and function of which is described more in detail in the following.

In the embodiment shown in FIG. 1 the container 8 is in the shape of a jacket which partly surrounds a combustion chamber 9. The pipe 7 is connected to the upper part of the container 8, to the lower part of which is connected another pipe 10. This pipe 10 has a branch 11 through which one end of a tube coil 12 is connected to the pipe 10 which beneath the branch 11 leads to a valve 14. This is a three-way valve, the first opening of which is connected to the pipe 10, the second opening to the lower end of the tube coil 12, and the third opening to a pipe 16. This latter pipe connects the valve 14 to the lower end of the tube coil 5 so that the parts 5, 7, 8, 10, 14 and 16 as now described form a continuous closed water system in which the tube coil 12 also can be connected. The pipe 7 connecting the container 8 with the tube coil 5 is connected to an expansion vessel 18 by a pipe. The combustion chamber 9 is arranged within a casing 35 which beneath the combustion chamber forms a chamber 22 and above said combustion chamber extends upwardly, terminating at the upper end in another chamber 21. The walls of these chambers 22, 21 are provided with air inlet apertures 27 and air outlet apertures 28, respectively. Inserted through the roof of the chamber 21 is a relatively large pipe 34 which is connected to a low chamber 33 placed within the chamber 21. This low chamber 33 is connected to the combustion chamber 9 by a number of tubes 32, which serve as discharge tubes for combustion gases which are thereby led up into the chamber 33 serving as a smokebox and from there through the pipe 34 to a chimney or into the atmosphere.

The casing 35 is so arranged that a passage 19 is formed between it and the combustion chamber 9 as well as the tubes 32 so that air can pass from the chamber 22 through the passage 19 to the chamber 21. To establish a flow of air in the described manner a fan 20 is arranged in the chamber 21. Said fan 20 is driven by a motor 36, and below the fan the aforesaid tube coil 12 is arranged in such a way that the air sucked in through the apertures 27 by the fan always sweeps along the walls of the tube coil. The said tube coil 26 is disposed in the passage 19 below the chamber 21.

A burner device, such as an oil burner 23, is provided in connection with the combustion chamber 9. This burner is controlled in such a way by a relay 24 which in turn is controlled by thermostat switches 29 and 30, 31 respectively, located in the chamber 21 and in the closed water system, as illustrated diagrammatically in FIGURE 3, that the combustion is interrupted when the temperature of the air or water at the thermostats reaches predetermined maximum values, and started again when said temperatures sink to likewise predetermined minimum values.

The valve 14 is connected by transmission means (not shown or described in detail) to a servomotor 38 which is adapted to be actuated in a manner known per se through a mechanism 37 controlled by the water temperature in the tank 4. The arrangement is such that at a low water temperature the valve 14 interrupts the communication between the pipe 16 and the lower end of the tube coil 12 and at an adjustable higher temperature it again establishes this communication. The

tube coil 12 is, like the remaining system, filled with water. When the communication with the pipe 16 is open there does not exist any communication between pipes 10 and 16 except through the tube coil 12. At a low temperature in the tank 4, however, the pipe 16 is directly connected with the pipe 10.

When the device is put in operation the motor 36 is started simultaneously with the combustion device 23. Cold air is then sucked in by the fan 20 through the apertures 27 into the chamber 22 from where it flows upwards through the passage 19. The air sweeps over the walls of the combustion chamber and the tubes. Said walls are swept from inside by the flames from the burner and by hot combustion gases which pass to the smokebox 33 and from there through the pipe 34. They will as a consequence be heated and in turn heat the flowing air. To provide for an efficient heating of the air, as large a surface as possible of the tubes must get in touch with the air flow. It may therefore be advantageous to force the air flow by vanes or like means to take a longer way than the most direct one, i.e., straight up through the passage 19 through the upper part of which (where the tube coil 26 is disposed) the air must, however, pass so that it sweeps over this tube coil also. It may also be desirable in certain cases to make the air flow adjustable so that a greater or smaller amount of the air can be led past the tube coil 26. Means for this purpose may be designed in a great many ways depending upon the desired distribution of the heat effect on the air and the water, respectively. When the heated air sweeps around the tube coil 26 the water therein will be heated, the air being simultaneously cooled somewhat. Thus the tube coil 26 serves as a cooling coil for the air whereby the latter at its entrance in the hot air chamber 21 will have a lower temperature than it would have had if said cooling had not taken place. The water which is heated in the container 8 partly surrounding the combustion chamber is subjected to a further heating in the tube coil 26 from which the water is passed on through the pipe 7 to the tube coil 5 where it gives off heat to the surrounding water in the tank 4 and is thus cooled while the water in the tank is heated. The cooled water then flows through the pipe 16 to the valve 14 which now keeps the communication between the pipe 16 and the pipe 10 open, and to the container 8 where the water is again heated and from where the water flows to the tube coil 26 for further heating etc. If the tank 4 is placed at a high level so that the water in the pipe system has to rise before the cooling and to sink after it, the circulation is thermosiphonic. The circulation may however also be maintained by means of a circulating pump, which permits placing the tank 4 at any desired level.

The water in the tank 4 is heated by the continued circulation to a temperature at which the thermostat means 37 is actuated so that the motor 38 is started and adjusts the valve 14. The direct communication between the pipe 16 and the pipe 10 is thus closed and the communication between the pipe 16 and the tube coil 12 is opened. When the water which is now hot circulates through this tube coil the latter will be heated. It is, however, simultaneously cooled by the entering cold air which in turn receives heat and then in a preheated state comes in contact with the combustion chamber and the tubes. By reason of the preheating the air will have a higher temperature when it reaches the tube coil 26. As long as said tube coil has a sufficiently low temperature to cool the air, i.e. to receive a sufficiently large amount of heat from it, the heating continues. When the water in the tank 4 has obtained a sufficiently high, i.e. desired temperature, the tube coil 26 also is so hot that it has a low cooling effect on the air. The air will therefore at its entrance in the hot air chamber 21 have so high a temperature that the thermostat means 29 is caused to respond for interrupting the combustion.

The motor 36 is not, however, influenced by the thermostat but continues to drive the fan so that the air continues to flow through the passage 19 and the chamber 22. The two tube coils 12 and 26 now have so high a temperature that the passing air is heated over a given desired minimum temperature. The water is thereby cooled somewhat. At its continued circulation through the tube coil 5 the water is again heated by the surrounding, now hot water in the tank 4 and when it again passes through the coils 12 and 26 it is still able to give off heat to the air. By reason of the great calorific value of the water and the relatively great amount of water in the circulating system and the tank 4 the air can be heated for a considerable time while the water is slowly cooled, the air temperature reached sinking however gradually to the corresponding extent. Finally, that temperature is reached, which was set beforehand as the desired minimum temperature and at which the thermostat means 29 causes the burner to be started again and kept in operation until the water has again been heated.

If hot water is drawn from the tank 4 it is replaced by cold water from the cold water line which enters through the inlet opening 2 and lowers the water temperature in the tank. The temperature is scanned by the mechanism 37 so that the latter—after the temperature has sunk to a predetermined minimum temperature—starts the motor 38 which adjusts the valve 14 and shuts off the tube coil 12 from the remaining system. At the same time the water in the tube coil 5 is cooled off and enters the container 8 surrounding the combustion chamber, at a lower temperature than before. Also when the water flows through the tube coil 26 it has a lower temperature than before. The air flow which after the tube coil 12 has been shut off is not preheated by this coil and which is now cooled by the tube coil 26, will as a result obtain so low a temperature at its entrance in the chamber 21 that the thermostat switch 29 causes the combustion to start again if it was interrupted before the hot water was drawn. If the combustion was in process already it goes on until the water and the air have again obtained the desired predetermined temperature, as already described.

At a very low air temperature and an active exchange of air in the premises to be heated, the water temperature may rise to its maximum before the air temperature has reached the desired level although both tube coils 12 and 26 give off heat to the air. In such a case the water would risk to boil if the thermostat means 30 and 31 did not function as safety means, either of them responding for interrupting the combustion. It should be possible, however—provided the needs of the air heating and water heating, respectively, are known beforehand—to dimension the device in such a manner that such a case happens but extremely seldom.

In a device for air heating alone, closing down of the source of heat implies an immediate and quick cooling of the air which rapidly reaches a temperature at which a heat supply must again take place. The heating also takes place rapidly, and the heat supply must therefore again be interrupted after but a short time. By reason of the short combustion and stand-still periods which will result from the insignificant inertia of the system, the temperature will rapidly vary between a maximum and a minimum, which brings discomfort, particularly for the section of the premises closest to the heating device. In the device according to the invention the air reaches almost immediately after the start of the combustion an agreeable temperature which is then maintained with insignificant variations for the entire time necessary for heating also the water to the desired temperature. When this has occurred but not before, the combustion is interrupted whereupon the air temperature slowly sinks to the desired minimum which can lie relatively high, due to the inertia of the system. The temperature variations in this system will be small and slow and can be made almost imperceptible in a device well conforming

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to the needs, for if reasonably ample amounts of water are drawn from the tank 4 the combustion is kept continuously operating and the air temperature is kept largely constant with the aid of the two tube coils 12 and 26.

The fact that the heat supply periods and the intervals between them can be made long, naturally implies a reduction of the number of starts and shutdowns during a given period of operation, which is advantageous particularly in oil-firing plants and installations comparable thereto. The advantages inherent in the device according to the invention may however be exploited with good results also in for instance electrically heated installations where in such a case the expensive temperature controlling means for the source of heat can be replaced by simple switches or like means because the temperature is kept agreeably constant even though the supply of heat is intermittent.

As the air heater and the water heater, when necessary, can borrow heat from each other in an optional direction, an installation according to the invention can be equipped with a source of heat of lower capacity than two corresponding separate devices. At a momentary overload the system having the less load can help the other. This naturally implies that the installation becomes cheaper, apart from the purely self-explanatory saving involved in erecting a single combustion apparatus instead of two.

It is possible, with the aid of various devices, to increase the capacity in one respect or other. Should for instance a particularly rapid heating of water be desired, some portion of the passage 19 can be designed so as to permit closing down, while the tube coil 26 is arranged in the portion not closed down. As a result, the hot air can be directed through the last-mentioned portion which consequently will have a higher temperature and a higher heating effect on the tube coil 26. The device may also be suited to special requirements by varying the number of coils and their ability to give off or take up heat at different occasions etc. To increase the heat transfer ability the tubes may consist of finned tubes.

The embodiment of the invention shown in FIG. 2 differs from that already described only in that certain parts thereof are of another design. The water heater 1 and the expansion vessel 18 are not shown in FIG. 2 which merely illustrates part of the pipes 7 and 16 which lead the circulating water to and from the water heater, respectively.

The water container 8 is designed in FIG. 2 as a jacket which entirely surrounds the combustion chamber 9 and which in turn is itself entirely enclosed in the casing 35. The pipe 7 which is connected to the upper part of the container 8 like in FIG. 1, is shown also in FIG. 2 as being in the form of a coil 26 disposed within the casing 35 above the combustion chamber 9. If desired, this coil may however be dispensed with. The pipe 10 which is connected to the lower part of the container 8 leads to a three-way valve 39 which replaces the three-way valve 14 in FIG. 1, and can be connected by means of this valve through a pipe 40 and via a circulating pump 41 either to the pipe 16 from the water heater or to one end of an air preheater 42 which has its counterpart in the tube coil 12 in FIG. 1. The other end of the air preheater 42 is connected by a pipe 43 to the circulating pump 41, jointly with the pipe 40. The provision of the three-way valve 39 adjacent the container 8 implies a more convenient placing thereof than in FIG. 1 but no modification in function. The air preheater is disposed in the lower part of the casing 35 adjacent the air inlet aperture 27 thereof, and beside the air preheater there is arranged a centrifugal fan 44 which replaces the fan 20 in FIG. 1 and as distinct from this has a horizontal shaft, for sucking in air through the aperture 27 and to deliver it in an upward direction after it has passed through the air preheater 42. The fan 44 is driven by a motor 45.

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The upper part of the casing 35 has the opening 28 for withdrawal of hot air, and arranged at the top of said part is the smoke box 33 to which are connected the smoke gas flues 32 leading from the combustion chamber 9 and from which the smoke gases can escape through a lateral outlet 46 to the chimney.

In connection with the combustion chamber 9 there is arranged an oil burner 23 like in FIG. 1. Furthermore, the device is to have relay and thermostat means arranged in the same manner as in FIG. 1, although they are not shown in FIG. 2.

The heating device described above with reference to FIG. 2 has entirely the same manner of operation as the one described in connection with FIG. 1.

It is possible to design the device according to the invention in several other ways which deviate from the examples shown. The units included in the device, such as the water heater, the combustion chamber, the burner and other devices, as well as the relative arrangement etc. of said units can deviate from what has been shown without leaving the scope of the invention. It should be pointed out especially that the tube coil 26 can be dispensed with at the expense of a certain delay in the heating of the water from its cold state.

What I claim and desire to secure by Letters Patent is:

1. A system for air heating and hot water production in buildings, comprising a casing having an inlet and an outlet, a combustion enclosure located at least partly within said casing, a heat supply means associated with said enclosure, air flow producing means associated with said casing for passing a flow of air through said casing from the inlet to the outlet thereof, heat exchange means extending through said casing from said combustion enclosure for heating said air on its way from said inlet to said outlet by heat exchange with the heat leaving said enclosure, water boiler means disposed in heat exchange relationship with said combustion enclosure, a hot water heater including a tank for connection in a domestic hot water system and a heat exchange element within said tank connected in a closed circuit with said water boiler means, a heat exchanger connected in said closed circuit at the inlet side of said water boiler means and disposed in the path of the air flow from said inlet to said air heating means, and through which heat exchanger water arriving from said heat exchange element circulates, and means in said closed circuit for temporarily by-passing said heat exchanger.

2. A system for air heating and hot water production in buildings, comprising a casing having an inlet and an outlet, a combustion enclosure located at least partly within said casing, a heat supply means associated with said enclosure, air flow producing means associated with said casing for passing a flow of air through said casing from the inlet to the outlet thereof, heat exchange means extending through said casing from said combustion enclosure for heating said air on its way from said inlet to said outlet by heat exchange with the heat leaving said enclosure, water boiler means disposed in heat exchange relationship with said combustion enclosure, a hot water heater including a tank for connection in a domestic hot water system and a heat exchange element within said tank connected in a closed circuit with said water boiler means, a heat exchanger connected in said closed circuit at the inlet side of said water boiler means and disposed in the path of the air flow from said inlet to said air heating means, and through which heat exchanger water arriving from said heat exchange element circulates, branch circuit means connected across said heat exchanger, and valve means combined with said branch circuit means for permitting a by-passing of said heat exchanger at intervals through said branch circuit means.

3. A system for air heating and hot water production in buildings, comprising a casing having an inlet and an outlet, a combustion enclosure located at least partly within said casing, a heat supply means associated with

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said enclosure, air flow producing means associated with said casing for passing a flow of air through said casing from the inlet to the outlet thereof, heat exchange means extending through said casing from said combustion enclosure for heating said air on its way from said inlet to said outlet by heat exchange with the heat leaving said enclosure, water boiler means disposed in heat exchange relationship with said combustion enclosure, a hot water heater including a tank for connection in a domestic hot water system and a heat exchange element within said tank connected in a closed circuit with said water boiler means, thermostat means inserted in said water boiler means and connected to said heat supply means and operative to cause said heat supply means to supply and cease to supply heat response to the temperature of the

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water in said water boiler means, a heat exchanger connected in said closed circuit at the inlet side of said water boiler means and disposed in the path of the air flow from said inlet to said air heating means, and through which heat exchanger water arriving from said heat exchange element circulates, and means in said closed circuit for temporarily by-passing said heat exchanger.

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