

[54] **COMBINATION ELECTRIC WATER HEATER AND ELECTRIC SPACE HEATER**

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[58] Field of Search **219/312, 320, 321, 219/341, 365, 369, 370, 485; 237/19; 165/61, 65**

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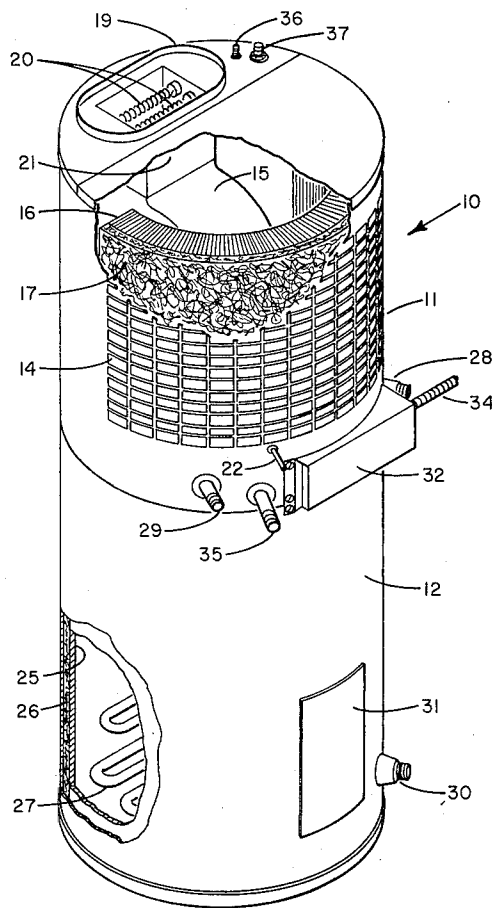
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[57] **ABSTRACT**

An electric water heater and an electric space heater are combined with a control system for supplying a combined demand-limited electric current. The control system is arranged to provide a predetermined desired priority to the various resistance heating elements in the combined system so as to limit the total electrical demand to less than the sum of the demands of all of the heater elements. The arrangement avoids the need for subdivided branch circuits with separate circuit breakers to comply with electrical codes.

7 Claims, 5 Drawing Figures



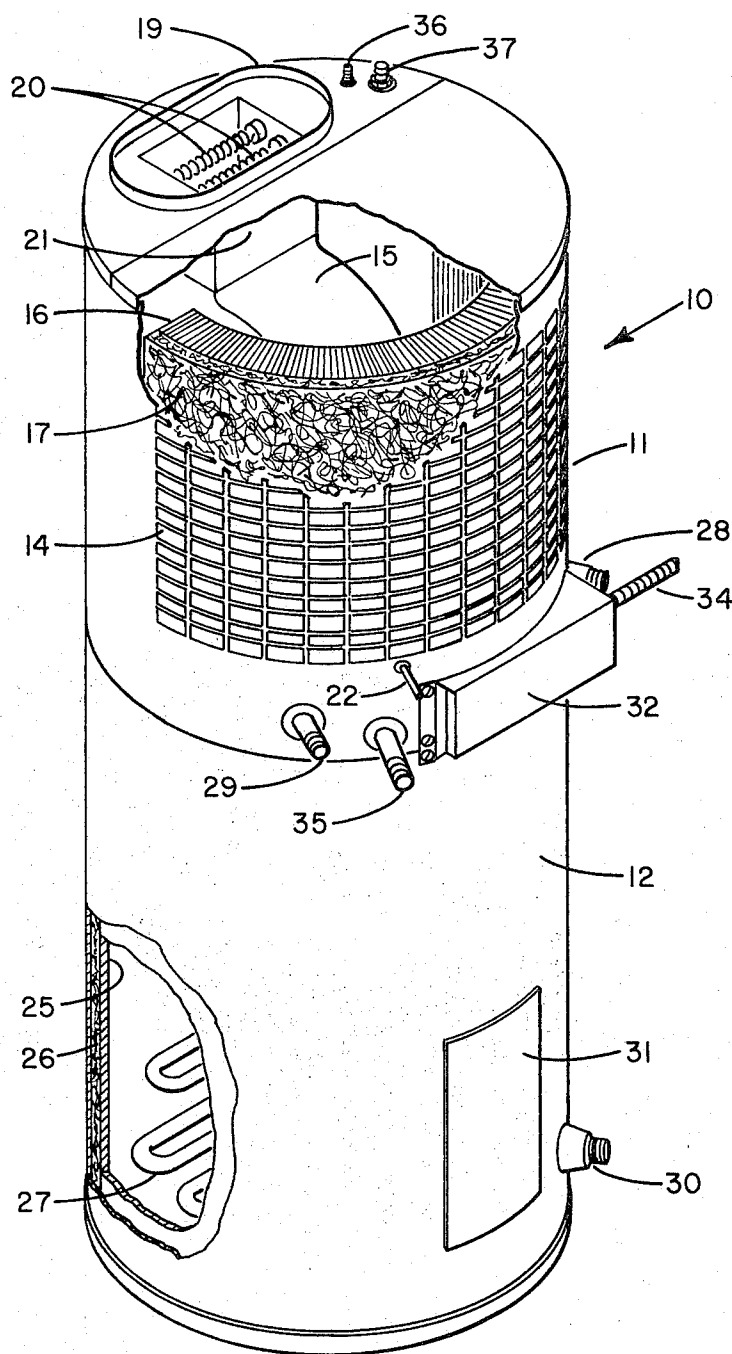


FIG. 1

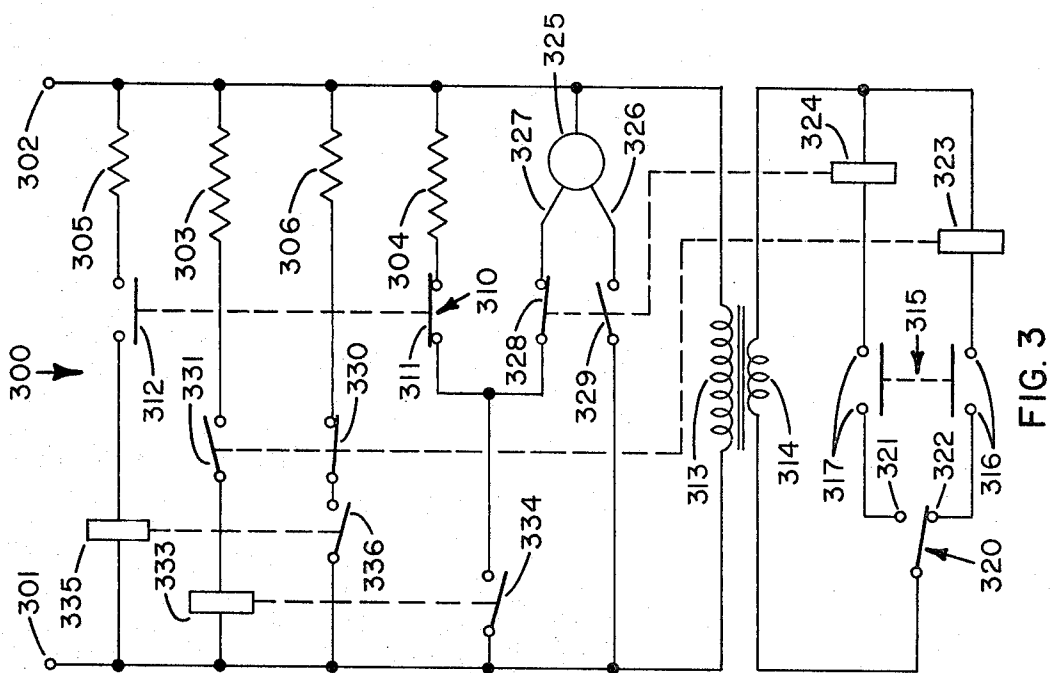


FIG. 3

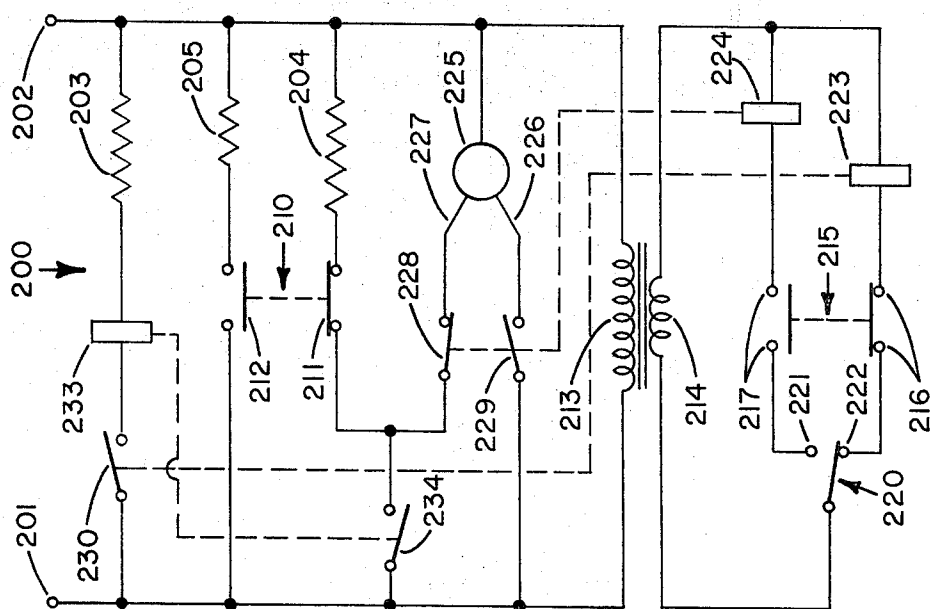
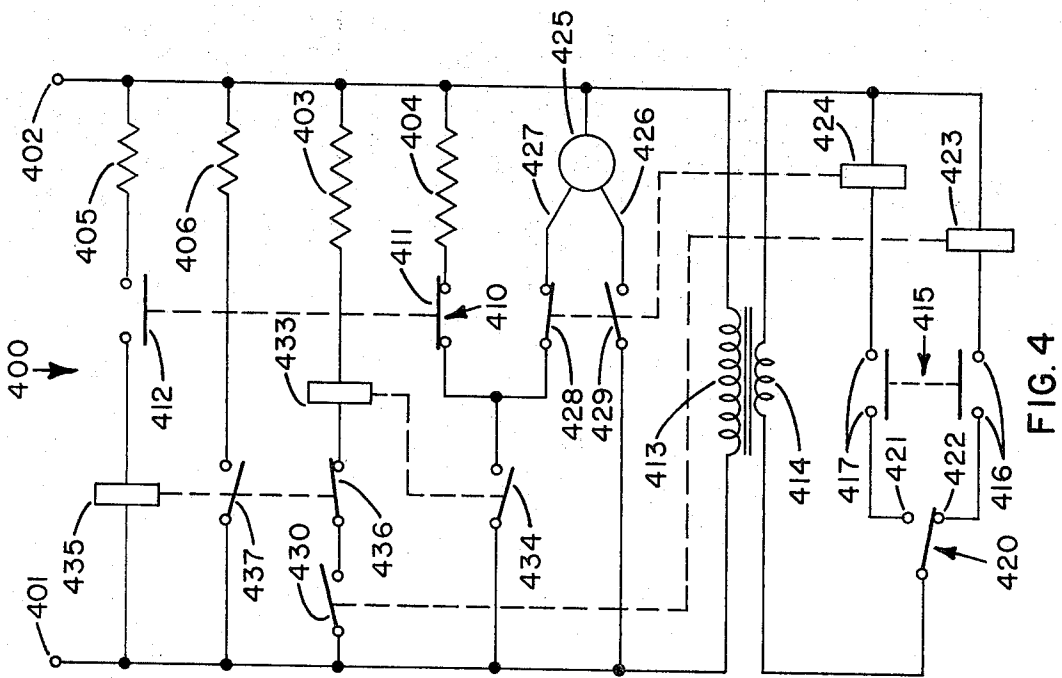
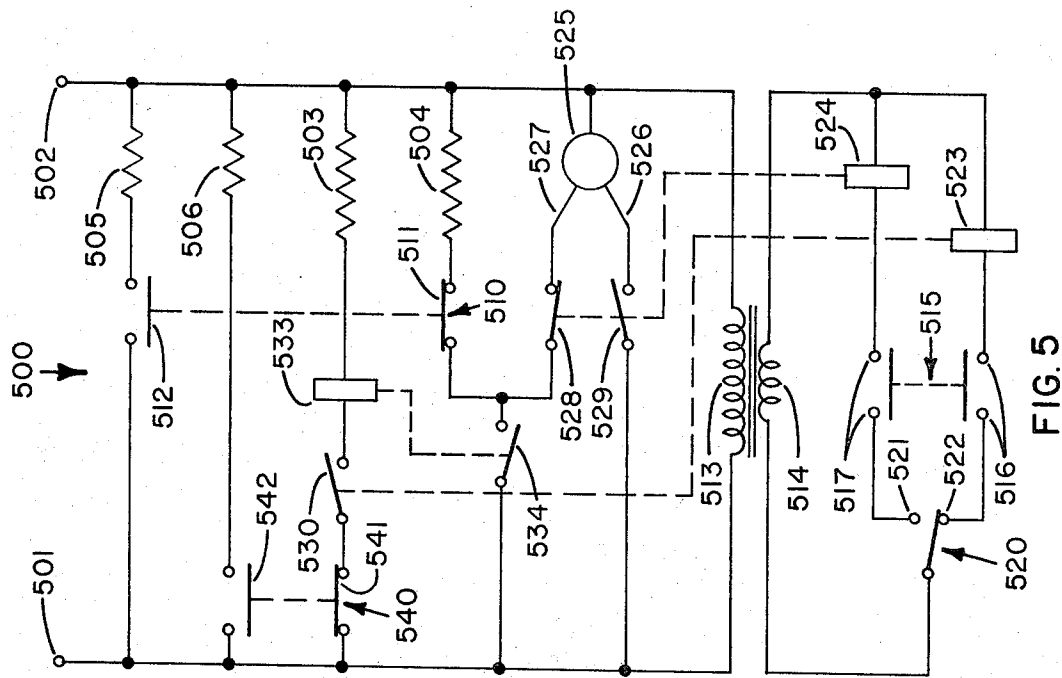


FIG. 2



COMBINATION ELECTRIC WATER HEATER AND ELECTRIC SPACE HEATER

BACKGROUND OF THE INVENTION

This invention relates to a combined electric water heater and electric space heater having a control system which provides a limited total current demand which is less than the total demand of all of the electric heater elements in the system.

Electrical codes normally impose a limit on the current that a single branch electrical circuit can handle. This requirement necessitates subdividing the electrical power circuits for supplying power to a unit having a larger electrical demand. Each of the subdivided circuits is required to be provided with its own power lines and circuit breaker protection systems. Consequently, the installation cost of a unit having a maximum electrical demand in excess of that permitted by a single electrical circuit is substantially increased by the code requirements.

Accordingly, it is an object of this invention to provide a combined electric water heater and electric space heater having a control which avoids the necessity of multiple branch electrical circuits by assigning a predetermined priority to the electrical demand of its various component heaters.

SUMMARY OF THE INVENTION

A combined electric water heater and electric space heater is provided with a control system for energizing the water heater elements in accordance with the water heating demand and energizing the space heating elements in accordance with the space heating demand. In the basic embodiment of the invention, wherein the system employs a single water heater element and two space heater elements, the circuit assigns a priority whereby one space heater element and one water element may be energized at any given time. However, the water heater element is assigned priority over the second space heater element so that the second space heater element can only be energized in the absence of a demand for water heating. Consequently, the electrical demand of the combined system is limited to a total demand less than the sum of the demands of each of the electrical heater elements, thereby avoiding the necessity of multiple branch circuit service to the unit.

In other embodiments of the invention, which employ multiple water heater elements as well as multiple space heater elements, various other priorities may be assigned to conform with the requirements imposed on the system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a combined electric water heater and electric space heater;

FIG. 2 illustrates a schematic electrical diagram of a control system for a combined system having three electric heater elements;

FIG. 3 illustrates a schematic electrical diagram of a control system for a combined system having four electric heater elements; and

FIGS. 4 and 5 illustrate modified electrical control circuits in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a combination electric water

heater and electric space heater 10 has an upper housing shell 11 and a lower housing shell 12 secured together by suitable means. Upper housing 11 is provided with an opening covered by grille 14 to admit air into the interior of the housing. An arcuately shaped refrigerant evaporator coil 16 is disposed behind grille 14 and a filter element 17 may be inserted between the evaporator coil and the grille as shown, or on the outside of the grille if desired. Evaporator coil 16 forms a portion of a refrigeration system (not illustrated) having a suitable remote condensing unit for supplying liquid refrigerant to the evaporator coil through fitting 36 and for withdrawing refrigerant vapor from the evaporator through fitting 37 to cool a space being air conditioned. A fan 15 is located in upper housing 11 within the arcuate section of evaporator coil 16 for drawing air to be conditioned through grille 14, filter 17 and coil 16 into the interior of upper housing 11. The air is then discharged from fan 15 through a suitable discharge duct which is connected to joint element 19 formed on the top of the housing.

One or more electric space heater elements 20 are provided within the discharge passage 21 of fan 15 for reheating of air being cooled and dehumidified or for providing heating of the air when refrigerant is not supplied to evaporator 16. A suitable condensate drain 22 extends from the lower portion of upper housing 11 to remove condensate formed during the passage of air over evaporator 16.

Lower housing shell 12 contains a water heater tank 25 which is insulated by a layer of fiber glass 26 from the exterior of the water tank. One or more electric hot water heater elements 27 are provided within the interior water heater tank 25 to provide the required water heating upon a demand therefor. An inlet connection 28 is provided for supplying water to tank 25 and an outlet connection 29 is provided for discharging heated water from the tank. In addition, a drain connection 30 is provided at the lower portion of tank 25 with a suitable valve to allow the tank to be drained, and a pressure relief valve drain 35 is provided adjacent the top of the tank. A removable access panel 31 is provided in lower housing shell 12 to enable servicing of water heater elements 27.

Electric service is provided by connecting an electric power line 34 to a control compartment 32. In accordance with this invention, it is contemplated that a single electrical service line will be provided to the unit, even though the total demand of all of the individual electric heater elements in the unit exceeds the total current capacity permitted for a single electric power circuit.

Referring particularly to FIG. 2, there is schematically illustrated an electrical control system 200 for limiting the total electrical demand on the combined system to less than the sum of the demands of each of the electric heater elements. Line current from a single branch electrical circuit is provided to control system 200 at terminals 201, 202. The basic system illustrated in this embodiment includes a two stage space heater comprising electric space heater elements 203 and 204 and the system includes a single stage electric water heater element 205.

A water heater thermostat 210 has a first normally closed switch 211 and a second normally open switch 212, responsive to a sensed demand for water heating imposed on the system. A transformer having a line

voltage primary winding 213 and a low voltage secondary winding 214 supplies current for operation of the low voltage controls in the system. The low voltage controls include a manually selectable heat-cool switch 215 for selecting either heating or air conditioning, as desired. Switch 215 is in a position to provide heating, terminals 216 are connected at each other, as illustrated in the drawing, and are in a position to provide air conditioning when terminals 217 are connected to each other.

Room thermostat 220 is located in the space to be conditioned for sensing a heating or cooling demand imposed on the system. When contact 222 of thermostat 220 is connected to the common terminal as illustrated in the drawing, the space to be heated is cooler than the set point temperature and a demand for heating is indicated. Conversely, when the heating demand is satisfied or there is a cooling demand imposed on the system, contact 221 of the thermostat is connected to the common terminal. When switch 215 is in the heating position, closing of contact 222 of the thermostat to the common terminal energizes space heat control relay 223; and when switch 215 is in the cooling position, closing of thermostat contact 221 to the common terminal energizes air conditioning relay 224. It will be apparent that if air conditioning is not desired, heat-cool switch 215 may be omitted.

A two speed electric fan motor 225, having a low speed terminal 227 and a high speed terminal 226, is provided for passing air over the electric space heater elements and to the space being heated. The low speed terminal 227 of fan motor 225 is in series with normally closed air conditioning relay contacts 228 and the high speed terminal 226 of the motor 225 is in series with normally open air conditioning relay contacts 229. Consequently, fan motor 225 normally runs on low speed during the heating mode of operation and is switched to high speed operation when air conditioning is required. In the event that air conditioning is not provided by the system, a single speed fan motor is preferably employed. Space heat control relay 223 has a pair of contacts 230 in series with time delay relay 233 and first space heater element 203.

When switch 215 is in the heat position and thermostat 220 demands heating, as shown in the drawing, space heat control relay 223 is energized and contacts 230 close. Closure of contacts 230 energizes time delay relay 233 and first space heater element 203. After a period of about 20 seconds, time delay relay contacts 234 close and complete the circuit through contacts 228 and terminal 227 to energize the low speed winding of fan motor 225.

Time delay relay 233 provides a period of time for space heater element 203 to warm up before fan motor 225 is energized. This prevents a cold blast of air from being discharged into the space being conditioned before the space heater is sufficiently warm to provide the required heat. In addition, closure of time delay relay contacts 234 also completes another circuit through normally closed switch 211 of water heater thermostat 210 to energize second space heater element 204, providing the water heater thermostat does not sense a demand for water heating.

In the event water heater thermostat 210 senses a demand for water heating, switch 211 opens de-energizing second space heater element 204 and switch 212 closes energizing water heater element 205. Con-

sequently, only a single stage of space heating is available until the water heating demand is satisfied, whereupon switch 211 again closes, allowing operation of second space heater element 204.

In the FIGS. 3, 4 and 5, modified embodiments of the invention are illustrated wherein similarly functioning elements are designated by similar numbers in the 300, 400 and 500 series, respectively.

Referring particularly to FIG. 3, the control system shown therein includes a second water heater element 306 in addition to first water heater 305 and space heaters 303 and 304. This system also includes a water heating time delay relay 335 having normally open contacts 336 associated therewith.

In this embodiment, a demand for space heating by thermostat 320 energizes space heat control relay 323 which closes contacts 331 and opens contacts 330 associated with the relay. Closing contacts 321 completes the circuit through space heating time delay relay 333 and first space heater element 303. Energizing of the space heating time delay relay results in closing contacts 334 after a short period of time, which in turn energizes the low speed winding of fan motor 325.

In the event there is no demand for water heating at the time, closing of space heat time delay relay contacts 334 also completes a circuit through normally closed water heater thermostat switch 311 and energizes second space heater element 304. However, if water heater thermostat 310 senses a demand for water heating, switch 311 will open to preclude energization of second space heater element 304, and water heater thermostat switch 312 will close, energizing water heater element 305 irrespective of the demand for space heating. When water heater thermostat 312 closes, water heating time delay relay 335 is energized, and after a period of time, its associated, normally open contacts 336 close. If, at the time contacts 336 close, there is not demand for space heating, space heat control relay contacts 330 will be in their normally closed condition and second water heater element 306 will become energized. If, on the other hand, a simultaneous demand for space heating is sensed by thermostat 320, space heat control relay contacts will be open, preventing energization of second water heater element 306.

Consequently, it will be seen that the control system of FIG. 3 assigns a priority to the space heater elements and the water heater elements such that one stage of water heating and one stage of space heating are always available on demand. A second stage of space heating or a second stage of water heating is also available providing there is no demand for the other heater elements. With this arrangement, only two of the electric heater elements can simultaneously operate, so the current demand by the combined water heater and space heater is limited to the maximum demand of two of the four heater elements.

In FIG. 4, there is illustrated a control system which assigns a higher priority to both electric water heater elements than to either space heater element in order to achieve the highest possible recovery rate for the hot water heater. In this circuit, the components are similar to those already described except that the water heater time delay relay 435 has an additional set of normally open contacts 437 which are in series with second water heater element 406.

When water heater thermostat 410 senses a demand for water heating, switch 412 closes and energizes first

water heater element 405 and time delay relay 435. A few seconds later, normally closed time delay relay contacts 436 open and normally open contacts 437 close, thereby energizing second water heater element 406. In the event that thermostat 420 has sensed a demand for space heating, the opening of contacts 436 de-energizes space heater 403 and opening of water heater thermostat switch 411 de-energizes space heater 404.

The above described arrangement is particularly useful where the storage capacity of the hot water heater is relatively low and the heat storage capacity of the space being heated is relatively high so that sacrificing space heating capacity for water heating capacity will not unduly discomfort the occupants of the space being heated.

FIG. 5 illustrates a control which represents a compromise between rapid water heater recovery and the desire for continuous space heating capacity. In this arrangement, a second water heater thermostat 540 is provided having a normally closed switch 541 and a normally open switch 542. Second water heater thermostat 540 is responsive to a greater demand for water heating than first water heater thermostat 510, and may be located at a different point in the hot water heater tank such as the upper region thereof. When there is a relatively small demand for water heating, water heater thermostat 510 will be actuated, whereby switch 511 will open and switch 512 will close. Opening of switch 511 will disable second space heater 504 and closing of switch 512 will energize first water heater element 505. In this manner, the system of FIG. 5 usually will be enabled to provide at least one stage of water heating and one stage of space heating.

If, on the other hand, the temperature of the water in the water heater drops still further, indicating a greater demand for water heating, water heater thermostat 540 will cause switch 541 to open and switch 542 will close. Opening of switch 541 will deenergize first space heater element 503, and closing of switch 542 will energize second water heater element 506. When the water heater has partially recovered, water heater thermostat 540 will return to its normal condition whereby first space heater 503 can again be energized and second water heating element 506 will be de-energized.

The arrangement just described has the advantage of sacrificing space heating in favor of a high water heater recovery rate for only a short period of time.

With each of the systems described, it will be seen that no more than two of the electric heater elements can be actuated at a given time, the various circuit arrangements predetermining the order of priority for energizing the heater elements. Typically, the space heater and water heater elements may have a current demand on the order of between 20 and 24 amperes and the electric fan motor may have a current demand on the order of 1 to 2 amperes. The current demand from the total system will be typically limited to less than 48 amperes under any condition of fan and heater operation. Obviously, other priorities and other numbers of heater elements may be employed in the system and the circuitry and functions may be varied to suit the requirements of a particular user so long as the system is programmed to maintain a limit on the current demand equal to or less than the maximum permissible current draw for a single circuit under the applicable codes.

The arrangement described reduces the installation cost of a combined electric water heater and electric space heater below that of the same capacity components utilizing separate controls by eliminating the necessity of separate circuit wiring with individual circuit breakers for each unit.

While preferred embodiments of this invention have been shown for purposes of illustration, it will be appreciated that various other circuits may be employed within the scope of the invention in a particular application and that the invention may be otherwise embodied within the scope of the following claims.

I claim:

1. A combination electric water heater and electric space heater comprising:
 - A. an electric space heater having a first electric space heater element and a second electric space heater element;
 - B. an electric water heater having an electric water heater element; and
 - C. a control system for selectively energizing the heater elements in the system, said control including:
 1. a space heater thermostat having a switch means associated therewith adapted to respond to the demand for space heating imposed on the system;
 2. a water heater thermostat having switch means associated therewith adapted to respond to the demand for water heating imposed on the system;
 3. said water heater element being connected in an electrical circuit controlled by said water heater thermostat to energize and de-energize said water heater element in response to the sensed demand for water heating;
 4. said first space heater element being connected in an electrical circuit controlled by the space heater thermostat to energize and de-energize said first space heater in response to the demand for space heating; and
 5. said second space heater element being connected in an electrical circuit controlled by both said space heater thermostat and said water heater thermostat to energize said second space heater element only when said water heater element is de-energized, whereby the total electrical demand by said combined system is limited to a demand less than the total demand of all of the heater elements in the system.
2. A combination electric water heater and electric space heater as defined in claim 1:
 - A. said water heater having a second electric water heater element; and
 - B. circuit means energizing the second water heater element upon a demand for water heating sensed by the water heater thermostat only when the space heater thermostat senses a satisfied space heating demand, whereby at least one stage of water heating and at least one stage of space heating are always available upon demand therefor, but the total electrical demand by the system is always limited to a demand less than that of all the heater elements in the system.
3. A combination electric water heater and electric space heater as defined in claim 1:

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- A. said water heater having a second electric water heater element; and
- B. circuit means for additionally energizing the second water heater element and for additionally de-energizing the first space heater element upon a demand being sensed by the water heater thermostat for water heating, whereby a demand for water heating is given priority over a demand for space heating to limit the total electrical demand on the system. 5
- 4. A combination electric water heater and electric space heater as defined in claim 1:
 - A. said water heater having a second electric water heater element; and
 - B. said second water heater element being connected in an electric circuit for energizing the second water heater element and de-energizing the first space heater element upon energizing of the first water heater element, whereby energizing of the space heater elements is preempted by a demand 10 for water heating.
- 5. A combination electric water heater and electric space heater as defined in claim 1:
 - A. said water heater having a second electric water heater element; and
 - B. said second water heater element being connected in an electric circuit for de-energizing said second water heater element when the space heater thermostat senses a space heating demand, whereby energization of said second water heater element is preempted by a demand for space heating, so that at least one stage of space heating and at least one stage of water heating is available upon a demand being sensed therefor. 20
- 6. A combination electric water heater and electric space heater as defined in claim 1:
 - A. said water heater having a second electric water

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- heater element;
- B. said water heater thermostat having a second switch means associated therewith adapted to respond to a greater demand for water heating being imposed on the system than the demand to which the first water heater thermostat switch means is responsive;
- C. said second water heater element being connected in an electric circuit with one of said second water heater thermostat switch means to energize and de-energize the second water heater element in response to said greater demand for water heating; and
- D. said first space heater element being additionally connected in an electric circuit with said second water heater thermostat switch means to energize said first space heater element only when said second water heater element is de-energized, whereby sensing of a greater water heating demand by said water heater thermostat preempts the space heating demand until said greater water heating demand is satisfied, thereby limiting the total electrical demand by the system.
- 7. A combination electric water heater and electric space heater as defined in claim 1 including:
 - A. an electrically driven fan for passing air over said electric space heater element and discharging the air into a space to be heated; and
 - B. time delay relay means connected in an electric circuit with said electric space heater element, for energizing said electrically driven fan after a period of time has elapsed subsequent to energizing of said space heater element, whereby the electric space heater element is enabled to heat up for a period of time before the fan discharges air into the space to be heated. 25

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