

June 5, 1945.

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2,377,440

WATER HEATING SYSTEM

Filed Jan. 1, 1944

2 Sheets-Sheet 1

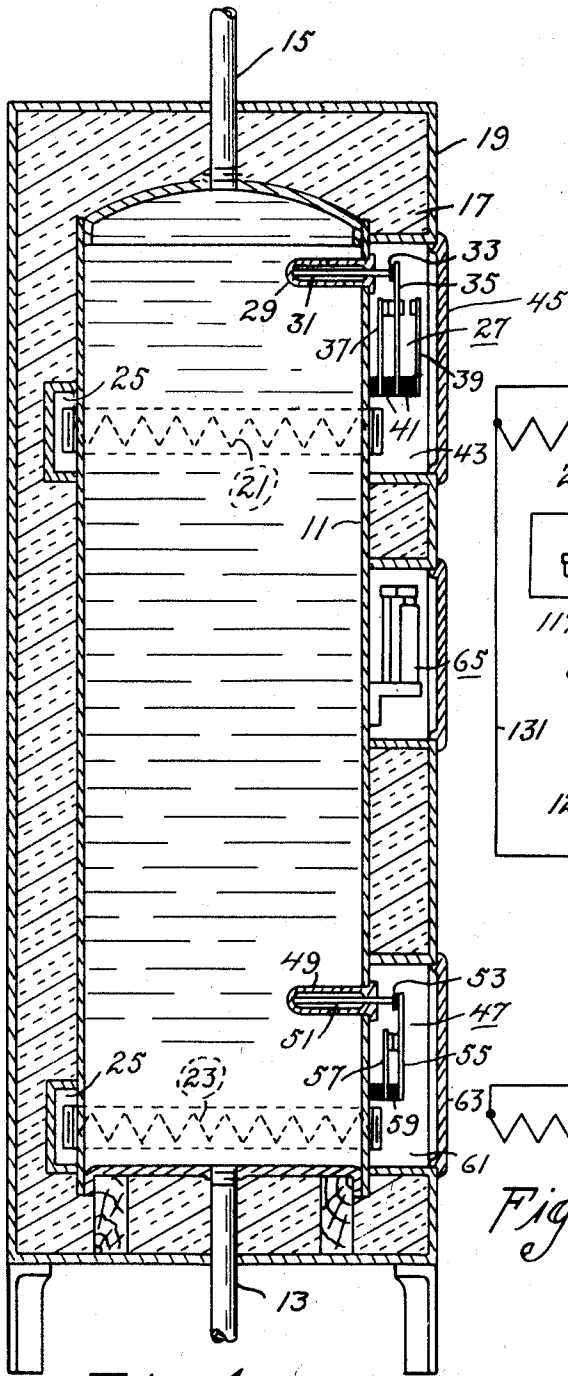


Fig-1

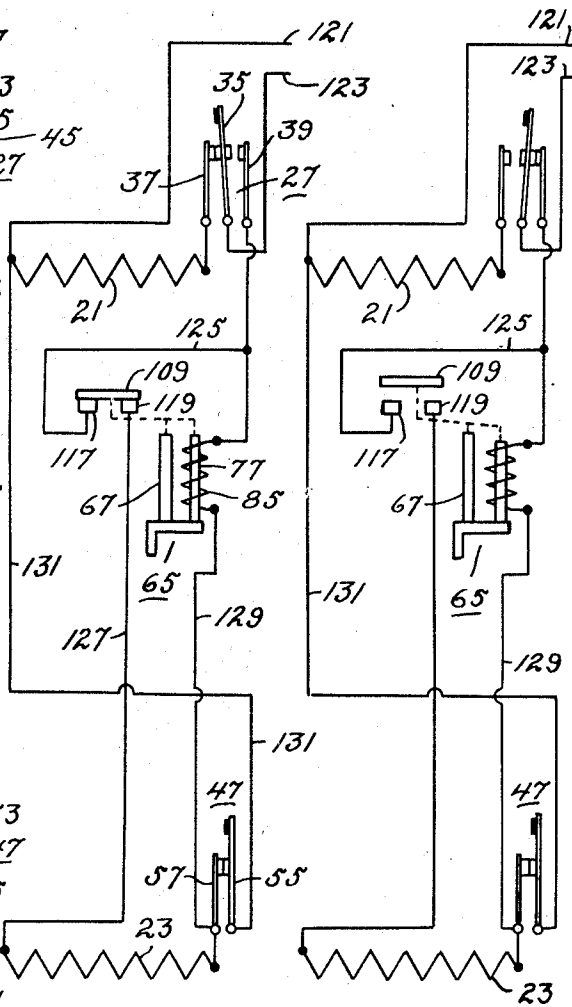


Fig-2

Fig-3

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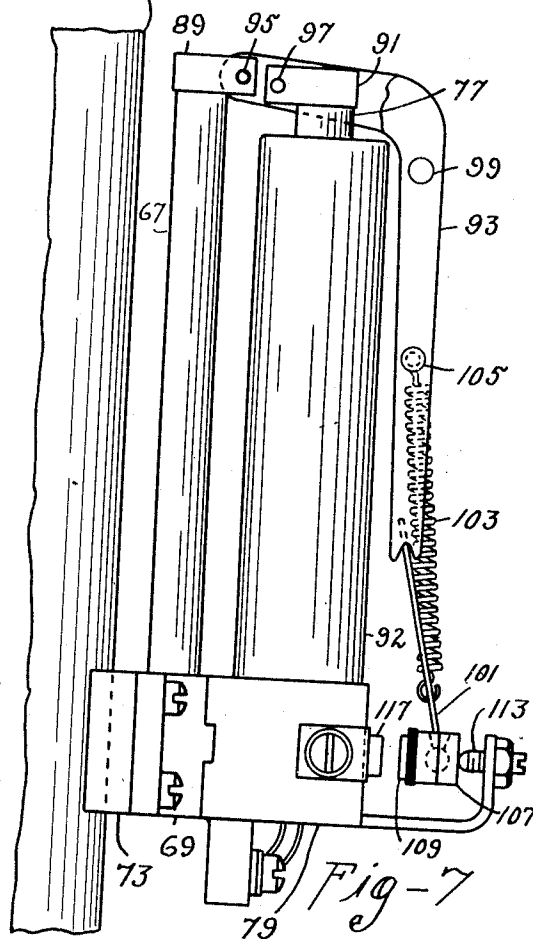
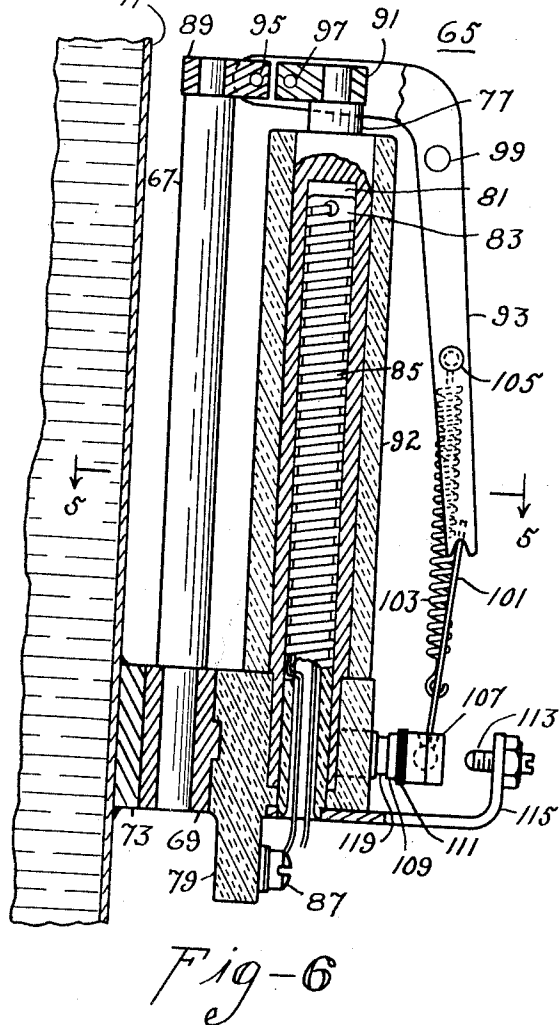
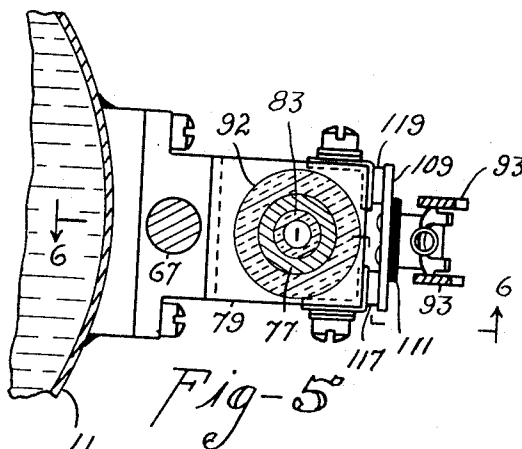
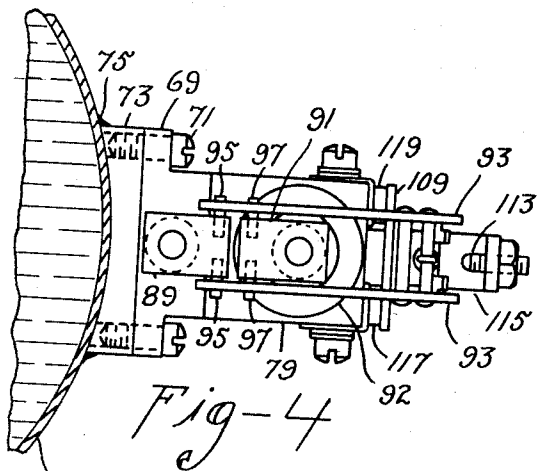
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WATER HEATING SYSTEM

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2 Sheets-Sheet 2



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WATER HEATING SYSTEM

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Application January 1, 1944, Serial No. 516,695

8 Claims. (Cl. 219—39)

My invention relates to electric heating and particularly to heater control systems for hot water tank heaters.

An object of my invention is to provide a control system for a pair of electric tank heaters to cause selective energization thereof with and without a time delay period for one of said heaters in accordance with the amount of hot water withdrawn from the tank.

Another object of my invention is to provide a control system for an upper and a lower tank heater that shall permit energization of only one of said heaters at any time and that shall cause energization of the lower heater with a time period of delay in case of use of a relatively small amount of hot water and that shall cause immediate energization of the lower heater in case of use of a predetermined relatively large, but less than the total amount of hot water.

Other objects of my invention will either be apparent from a description thereof or will be pointed out hereinafter and set forth in the appended claims.

In the drawings,

Figure 1 is a view in vertical section through a domestic hot water tank having associated therewith my improved heater control system,

Fig. 2 is a diagram of the electrical connections utilized in my control system showing the energization only of the upper tank heater,

Fig. 3 is a diagram of connections showing the positions of the parts when the upper portion of the tank is filled with hot water,

Fig. 4 is a top plan view of a thermal retarder switch unit shown in Fig. 6,

Fig. 5 is a horizontal section therethrough taken on the line 5—5 of Fig. 6,

Fig. 6 is a vertical section therethrough taken on the line 6—6 of Fig. 5, and,

Fig. 7 is a view in side elevation thereof.

I have shown, in Fig. 1 of the drawings, an ordinary domestic hot water tank 11 having a lower cold water inlet pipe 13 and an upper hot water outlet pipe 15 secured thereto. I provide a covering 17 of the usual heat-insulating material and an outer casing 19 all in a manner now well known in the art.

I provide an upper electric heater 21 and a lower electric heater 23, these two heaters being supported around the outside of the tank 11 and positioned in tunnels 25, also in a manner now well known in the art. I provide an upper thermal heater control switch designated in its entirety by numeral 27 which I have shown as comprising a tube 29 having a closed inner end, with

its outer end secured in fluid-tight engagement in an opening in tank 11 near the upper end portion thereof. I provide an expansion rod 31 in tube 29 adapted to engage a lug 33 which is secured to the outer movable end of a resilient contact arm 35. The resilient contact arm 35 has mounted thereon contact members adapted to engage with an inner substantially rigid contact arm 37 and with an outer substantially rigid contact arm 39 which arms may be supported in proper operative position as by blocks 41 of electric-insulating material so that normally contact arm 35 engages inner contact arm 37. I desire to point out that the showing of switch 27 is schematical only and that I may utilize any other thermal control switch effective for the same object and end. The switch 27 is positioned in an opening 43 in heat insulation 17 and may be covered by a cover member 45. I wish to here point out that the upper thermal heater control switch 27 is so designed and connected that it controls not only the energization of the upper heater 21 but also the energization of the lower heater 23 as will be hereinafter set forth.

I provide a lower thermal heater control switch 47 including a tube 49 similar to tube 29, an expansion rod 51 in tube 49 adapted to engage a lug 53 of electric-insulating material secured to the free end of a resilient contact arm 55 having a contact member thereon adapted to be engaged with and disengaged from a contact member on a substantially rigid arm 57. Blocks 59 of electric-insulating material may be utilized to support the two arms 55 and 57 on the tank adjacent the lower end portion thereof with arm 55 normally biased into engagement with the contact arm 57. Switch 47 may be located in an opening 61 in the heat insulation and be covered by a cover member 63.

In addition to the two thermal heater control switches 27 and 47 I provide intermediate the ends of the tank a thermal retarder heater control switch unit designated generally by numeral 65. The thermal retarder switch unit 65 includes a first high expansion rod 67, the lower reduced end portion of which is adapted to fit into an opening in a block 69 of heat-conducting metal or alloy. The block 69 may be secured as by machine screws 71 against a heat-conducting mounting block 73 which has an arcuate inner surface to cooperate with the arcuate outer surface of the tank to provide a good heat-conducting engagement therebetween. Support 73 may be held in proper operative position by welding seams 75.

I provide a second thermally-expansive rod 77

which is made of an alloy or a metal having lower thermal expansivity than rod 67. The lower reduced end portion of rod 77 fits into an opening in a block 79 of heat-insulating material secured to block 69. Rod 77 has a central bore 81 therein in which is mounted a heating coil comprising a substantially cylindrical support 83 having wound thereon a low wattage heating coil 85, the terminals of which may be connected to contact terminals 87 supported by block 79. Each of the rods 67 and 77 have rigidly secured thereto at their reduced upper ends short arms 89 and 91 extending toward each other. I provide a heat-insulating cover 92 on the second rod 77.

I provide an upper toggle member 93 having two bars, each of L-shape, the upper end portions of these bars being supported by pivot pins or trunnions 95 and 97 secured in the arms 89 and 91. I provide a cross bar 99 extending through the two bars of arm 93 to hold them in proper operative position relatively to each other. I provide a lower toggle arm 101 which has pivotal engagement with the lower end portion of the upper toggle arm 93 and I provide also an over center spring 103, the upper end of which is connected to a cross bar 105 mounted in upper toggle arm 93 while the lower end thereof is connected to a portion of lower toggle arm 101 intermediate its ends.

I provide a block or bar 107 secured to the lower end of lower toggle arm 101 and mount thereon a contact bridging member 109 insulated from block 107 by electric-insulating material 111. I provide further a stop 113 supported by a bracket member 115, which bracket member is supported by blocks 79. I provide a pair of contact terminals 117 and 119 adapted to be engaged by contact bridging member 109 and support these contact terminals on block 79 of electric-insulating material.

The thermal retarder switch unit is disclosed and claimed in my co-pending application, S. N. 511,387, filed Nov. 22, 1943, and assigned to the same assignee as is the present application.

Referring now to Figs. 2 and 3 of the drawings I have there shown a pair of supply circuit conductors 121 and 123, conductor 121 being connected to one terminal of the upper heater 21 while the other conductor 123 is connected to the central resilient contact arm 35. The other terminal of upper heater 21 is connected to the inner rigid contact arm 37. The other rigid contact arm 39 is connected by a conductor 125 to contact terminal 117 while contact terminal 119 is connected by a conductor 127 with one terminal of the lower heater 23. The other terminal of lower heater 23 is connected to rigid contact arm 57 and by a conductor 129 with one terminal of the heating coil 85, the other terminal of which is connected to conductor 125. The resilient contact arm 55 is connected by a conductor 131 with the one terminal of upper heater 21 and therefore to supply circuit conductor 121.

Fig. 2 shows the positions of the three heater control switches; namely, the upper thermal heater control switch 27, the thermal retarder heater control switch 65 and the lower thermal heater control switch 47, which they would occupy when the tank is first filled with cold water or during normal operation thereof in case substantially all of the hot water has been withdrawn from the tank. The lower thermal heater control switch 47 will be in closed position, the thermal retarder switch unit will be in closed

position and the upper thermal heater control switch 27 will have its resilient contact arm 35 in engagement with rigid contact arm 37.

The thermal retarder switch design, construction and adjustment is such that when the two expansion rods 67 and 77 are at substantially the same low temperature, as they will be when the tank is first filled with cold water and the control system is energized, the contact bridging member 109 will be in engagement with contacts 117 and 119 to thereby close the switch. If now expansion rod 67 is subject to the temperature of hot water in the tank, contact bridging member 109 will be moved out of engagement with contacts 117 and 119 to open the circuit controlled by the thermal retarder switch, this condition being shown in Fig. 3 of the drawings. But if the second expansion rod 77 has been caused to expand by reason of energization of the heating coil 85 for a time period on the order of three to five hours, the second expansion rod 77 will be at a relatively high temperature, and its length will be such as to cause reclosure of the thermal retarder switch, the positions being those shown in Fig. 2 of the drawings.

Energization of the upper heater 21, as was hereinbefore set forth, will continue until such time as the upper thermal heater control switch 27 is subject to hot water when the intermediate contact arm 35 will be moved from the position shown in Fig. 2 of the drawings to the position shown in Fig. 3 of the drawings whereby upper heater 21 is deenergized. Engagement of contact arm 35 with contact arm 39 causes energization of lower heater 23 through the closed thermal heater control switch 47 as well as through the switch of the thermal retarder. As is well known, the entrance of cold water at the lower end portion of the tank ensures that any hot water in the tank will be located in the upper end portion thereof and, as also hereinbefore stated, this is when only enough water has been heated to subject the upper thermal heater control switch 27 to the action of hot water.

Energization of the lower heater 23 will now take place and continue until the thermal retarder switch unit is subject to the temperature of hot water and depending upon whether the length of time required to cause the heating-up of sufficient water in the upper portion of the tank to subject the thermal retarder switch unit to the temperature of hot water is more than the time required to cause heating-up of the second expansion rod 77, the thermal retarder switch will remain in closed position to continue energization of the lower heater 23. If on the other hand the thermal retarder switch 65 is subject to the temperature of hot water in a shorter time than is necessary to heat the second expansion rod 77 to its maximum temperature, the thermal retarder switch will be moved to open position because of the expansion of high-expansion rod 67 with consequent temporary interruption of the energization of the lower heater 23.

When the second expansion rod 77 is at its maximum temperature, the energization of the lower heater 23 will continue until substantially all of the water in the tank is hot, whereupon the lower thermal heater control switch 47 will be moved to open position to thereby interrupt the energization of heater 23.

Let it now be assumed that a relatively small amount of hot water is withdrawn from the tank so that cold water will enter the tank at the

lower end thereof in quantities sufficient to subject tube 49 to cold water. This will close the lower thermal heater control switch 47 which will cause energization of heating coil 85 through not only the lower thermal heater control switch but also the upper thermal heater control switch 27, the intermediate arm 35 of which is in the position shown in Fig. 3 of the drawings. Energization of coil 85 will continue until such time when the second expansion rod 77 will have been heated to a temperature sufficient to cause its length to increase to a value sufficient to cause closure of the snap-acting switch hereinbefore described. When this happens, and for illustrative purposes, the time delay period of closure may be on the order of three, four or five hours, then the lower heater 23 will be energized to cause heating-up of the cold water in the lower portion of the tank.

Let it be assumed, however, that a relatively larger amount of hot water was withdrawn from the tank, sufficient to subject not only the lower thermal switch 47 but also the thermal retarder switch 65 to its action, the result will be that the lower thermal switch 47 will be in closed position as will also be the thermal retarder switch 65 because of the decrease in length of the high-expansion rod 67. In this case energization of the lower heater 23 will not be delayed but will take place immediately, the sequence of actions being the same as has already been hereinbefore described.

It is therefore evident that should only a relatively small amount of hot water be withdrawn from the tank initially with consequent energization of the heating coil 85 to provide a time period of delay of energization of the lower heater 23 and should an additional amount of hot water be withdrawn from the tank sufficient to subject the thermal retarder switch to cold water, energization of the lower heater 23 will no longer be delayed but will take place immediately.

Let it be further assumed that substantially all of the hot water in the tank is withdrawn, this will result in the parts of the system returning to the positions shown in Fig. 2 of the drawings with resultant immediate energization of only the upper heater, after which the sequence of operations will be as has already been hereinbefore described.

The system embodying my invention therefore provides more particularly a time delay period for the energization of the lower heater in case of withdrawal of only relatively small amounts of hot water and will cause immediate reenergization of the lower heater in case of withdrawal of larger amounts of hot water from the tank.

Various modifications may be made in the system embodying my invention without departing from the spirit and scope thereof and all such modifications clearly coming within the appended claims shall be considered to be covered thereby.

I claim as my invention:

1. A water heater system having a tank and electric heating units at the top and at the bottom portions thereof, a thermally-actuable control switch for said top heater effective to close the circuit of the top heater when the temperature of the water at the top of the tank is below a predetermined value, a thermal retarder switch unit mounted on the tank intermediate the ends thereof comprising a pair of dissimi-

larly thermally-responsive elements and including a control switch for the bottom heater and a thermally-actuable control switch for the bottom heater subject to tank water temperature at the bottom portion of the tank, said system being effective when the tank is first filled with cold water to effect energization of said top heater alone through its control switch, said top heater control switch being opened when a predetermined quantity of water in the top portion of the tank has been heated to a predetermined high temperature and moved to a position for jointly cooperating with said control switches for the bottom heater to effect energization of the bottom heater until substantially the entire tank is filled with hot water.

2. A water heater system comprising a tank having a cold water inlet at the lower portion of the tank, a hot water outlet at the top portion of the tank, electric heaters for the top and the bottom portions of the tank, thermally-actuable control means responsive to the temperature of the water in the top portion, the bottom portion and an intermediate portion of the tank for controlling said heaters so that when only a small quantity of hot water is drawn off heat is applied only to the bottom portion with a predetermined delay period after such use but in case of use of substantially all of the hot water in the tank, heat is applied only to the upper portion of the tank to heat that portion of the water which is available for immediate use.

3. A water heating system comprising a tank having a cold water inlet at the lower portion of the tank, a hot water outlet at the top portion of the tank, electric heaters for the top and bottom portions of the tank, a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both the heaters for the top and the bottom portions, a thermal retarder switch unit responsive to the temperature of the water in an intermediate portion of the tank and including a control switch for the bottom heater and a thermally-actuable control switch responsive to the temperature of the water in the bottom portion of the tank for controlling said bottom heater, so that when only a small amount of hot water is used said three control switches are in position to effect energization of said lower heater only with a predetermined period of time delay after such use of hot water but in case of use of substantially all of the hot water in the tank said control switches are in position to effect energization of said top heater only until a predetermined quantity of water has been heated to a predetermined high temperature.

4. A water heating system comprising a tank having a cold water inlet at the lower portion of the tank, a hot water outlet at the top portion of the tank, electric heaters for the top and bottom portions of the tank, a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both the heaters for the top and bottom portions, a thermal retarder switch unit responsive to the temperature of the water in an intermediate portion of the tank and including a control switch for the bottom heater and a thermally-actuable control switch responsive to the temperature of the water in the bottom portion of the tank for controlling said bottom heater, so that when only a small amount of hot water is used said three control switches are in position to effect energization of said lower

heater only with a predetermined period of time delay after such use of hot water but in case of use of substantially all of the hot water in the tank said control switches are in position to effect energization of said top heater only until a predetermined quantity of water has been heated to a predetermined high temperature whereupon said top heater is deenergized by said top heater control switch moving to a position cooperative with said other two control switches to cause energization of said bottom heater only until the temperature of the water in the bottom portion of the tank reaches a predetermined high value.

5. A water heating system for a tank having a cold water inlet at the bottom end of the tank, a hot water outlet at the top of the tank and electric heaters for the top and for the bottom end portion of the tank, comprising a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both heaters, a thermally-actuable control switch subject to tank water temperature at the bottom end of the tank for controlling the heater at the bottom end of the tank, a thermal retarder switch unit subject to tank water temperature intermediate the ends of the tank, including a switch connected in series circuit with said bottom switch for controlling said bottom heater and including a pair of expansion elements, one of which is subject to tank water temperature and the other of which has a heating coil controlled by said top and said bottom switch, said three switches causing energization of the top heater alone in case the tank is full of cold water and causing energization of said bottom heater alone when a predetermined quantity of water in the top of the tank has been heated.

6. A water heating system for a tank having a cold water inlet at the bottom end of the tank, a hot water outlet at the top of the tank and electric heaters for the top and for the bottom end portion of the tank, comprising a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both heaters, a thermally-actuable control switch subject to tank water temperature at the bottom end of the tank for controlling the heater at the bottom end of the tank, a thermal retarder switch unit subject to tank water temperature intermediate the ends of the tank, including a switch connected in series circuit with said bottom switch for controlling said bottom heater and including a pair of expansion elements, one of which is subject to tank water temperature and the other of which has a heating coil controlled by said top and said bottom switch, said three switches causing energization of the top heater alone in case the tank

is full of cold water and causing energization of said bottom heater alone when a predetermined quantity of water in the top of the tank has been heated and said bottom thermal switch causing deenergization of said bottom heater when all of the water in the tank is hot.

7. A water heating system for a tank having a cold water inlet at the bottom end of the tank, a hot water outlet at the top of the tank and electric heaters for the top and for the bottom end portions of the tank, comprising a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both heaters, a thermally-actuable control switch subject to tank water temperature at the bottom end of the tank for controlling the heater at the bottom end of the tank, a thermal retarder switch unit subject to tank water temperature intermediate the ends of the tank, including a switch connected in series circuit with said bottom switch for controlling said bottom heater and including a pair of expansion elements, one of which is subject to tank water temperature and the other of which has a heating coil controlled by said top and said bottom switch, said three switches causing energization of the bottom heater alone with a predetermined time period of delay in case of withdrawal of a relatively small predetermined quantity of hot water from the tank and causing energization of the bottom heater alone immediately in case of withdrawal of a relatively large quantity, but less than all, of the hot water in the tank.

8. A water heating system for a tank having a cold water inlet at the bottom end of the tank, a hot water outlet at the top of the tank and electric heaters for the top and for the bottom end portions of the tank, comprising a thermally-actuable control switch responsive to the temperature of the water in the top portion of the tank for selectively controlling both heaters, a thermally-actuable control switch subject to tank water temperature at the bottom end of the tank for controlling the heater at the bottom end of the tank, a thermal retarder switch unit subject to tank water temperature intermediate the ends of the tank, including a switch connected in series circuit with said bottom switch for controlling said bottom heater and including a pair of expansion elements, one of which is subject to tank water temperature and the other of which has a heating coil controlled by said top and said bottom switch, said three switches causing energization of the bottom heater alone with a predetermined time period of delay in case of withdrawal of a relatively small predetermined quantity of hot water from the tank.

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