Oct. 7, 1947. C. M. OSTERHELD 2,428,525

THERMAL RETARDER

Filed Sept. 20, 1944 3 Sheets-Sheet 1

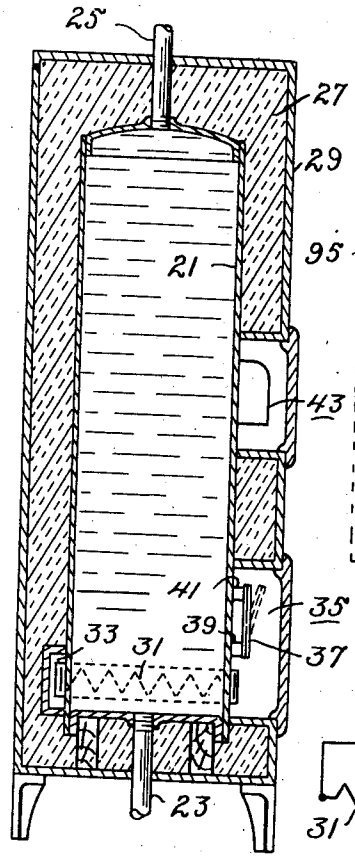


Fig-1

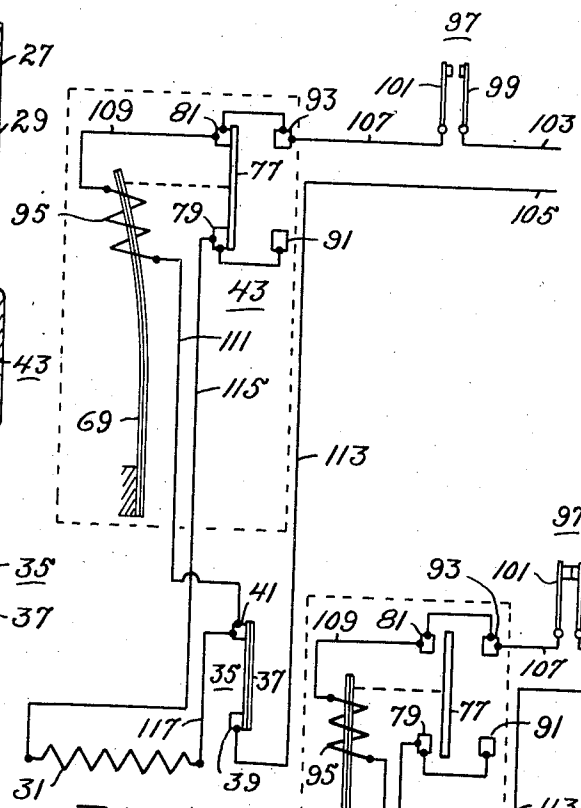


Fig-2

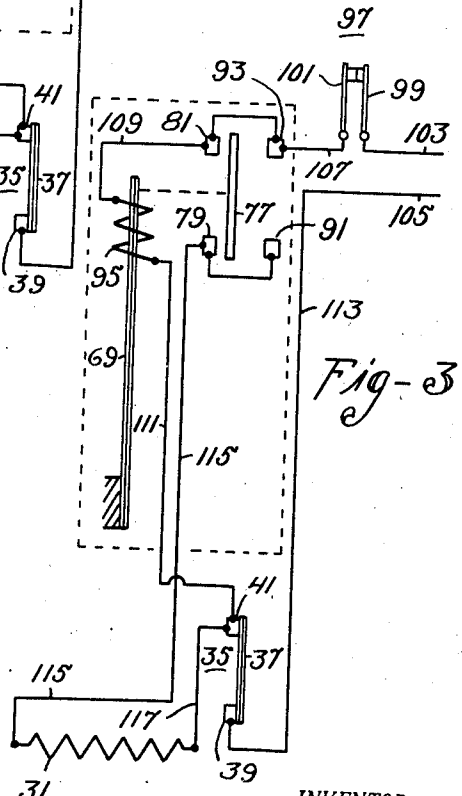


Fig-3

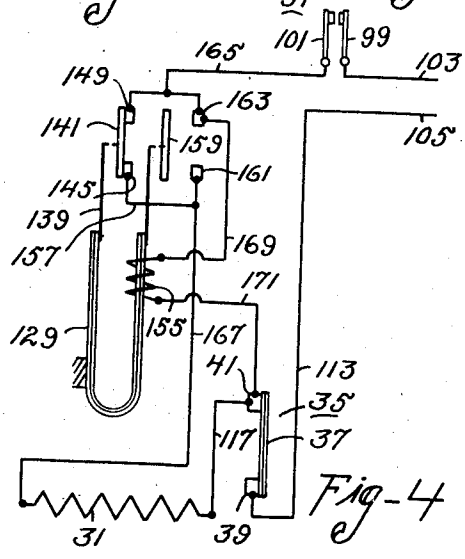


Fig-4

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THERMAL RETARDER

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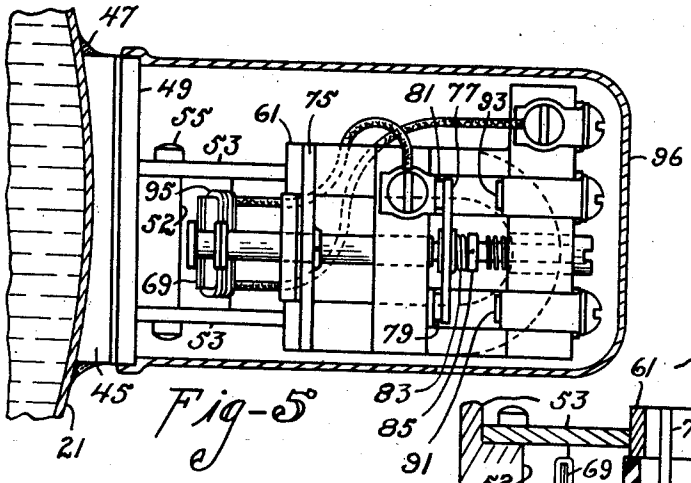


Fig-5

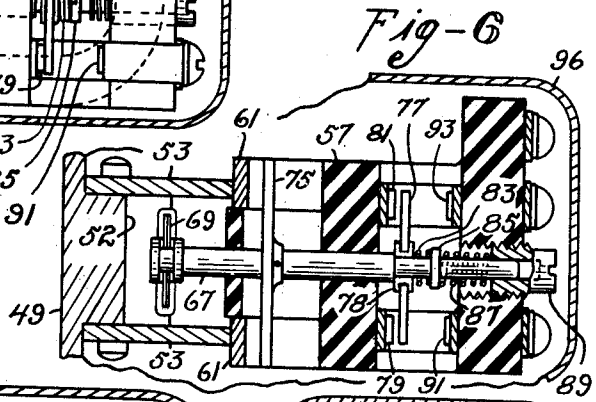


Fig-6

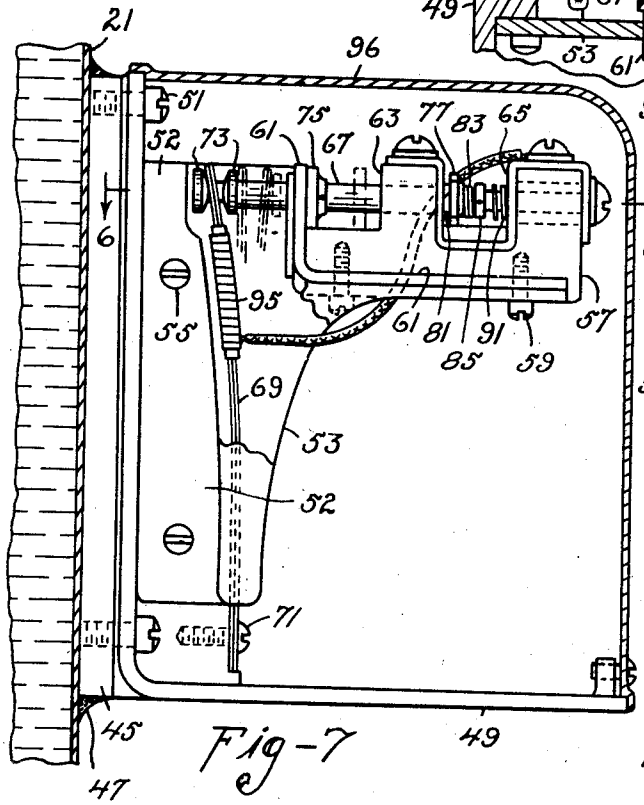


Fig-7

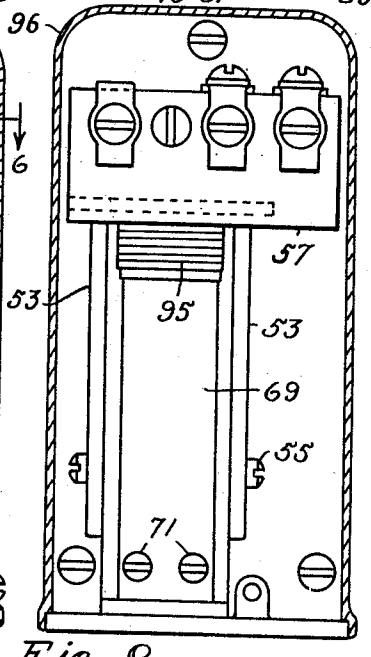


Fig-8

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THERMAL RETARDER

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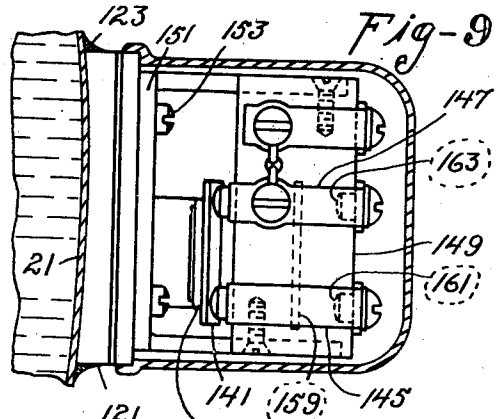


Fig-9

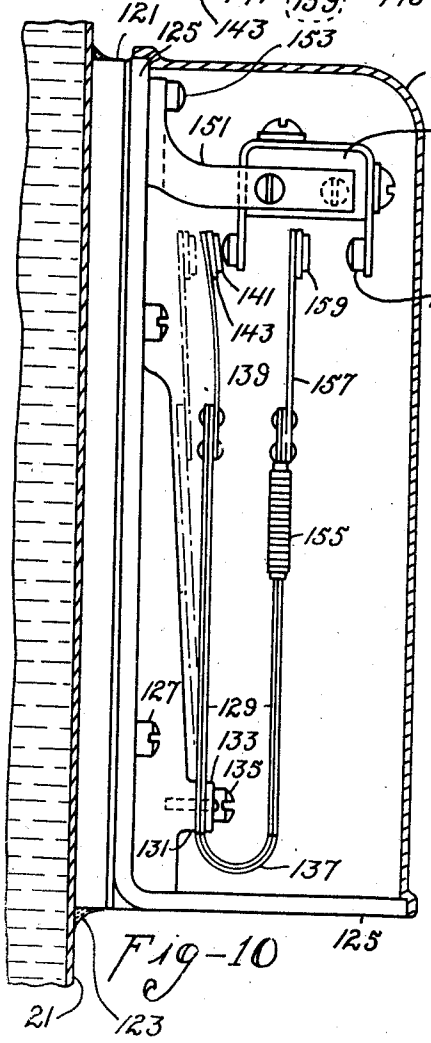


Fig-10

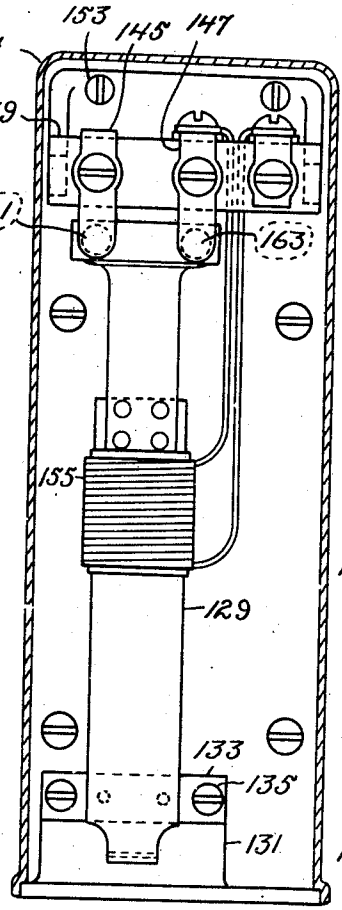


Fig-11

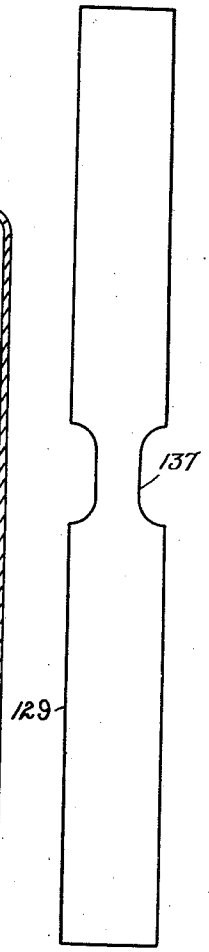


Fig-12

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2,428,525

UNITED STATES PATENT OFFICE

2,428,525

THERMAL RETARDER

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Application September 20, 1944, Serial No. 554,998

6 Claims. (Cl. 219—39)

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My invention relates to electric heater control devices and particularly to thermal retarder heater control switch units.

An object of my invention is to provide a relatively simple, inexpensive, easily manufactured, and properly operative structure to selectively cause immediate energization of the electric heater of a domestic hot water tank or energization of the heater with a predetermined time delay in accordance with the amount of cold water in the tank at the start of an off-peak period.

Other objects of my invention will either be apparent from a description of two forms of devices embodying my invention or will be set out in the course of such description and particularly in the appended claims.

In the drawings,

Figure 1 is a vertical, sectional view through a domestic hot water tank having associated therewith a thermal retarder embodying my invention,

Fig. 2 is a diagram of electric connections showing the contacts in the positions occupied by them when the tank is full of cold water and the time switch is open.

Fig. 3 is a diagram of connections showing the contacts in the positions occupied by them when the tank is more than half full of hot water positioned in its top portion and containing cold water in the bottom portion, the time switch being closed as at the start of an off-peak period,

Fig. 4 is a diagram of connections including a modified form of thermal retarder shown particularly in Figs. 9 to 12, the contacts being shown in this figure as when the tank is full of cold water,

Fig. 5 is a top plan view of the first form of thermal retarder embodying my invention, the cover being shown in section with the contacts shown in the positions they occupy in Fig. 2,

Fig. 6 is a horizontal, sectional view therethrough, taken on the line 6—6 of Fig. 7, with the contacts shown in the positions they occupy in Fig. 3.

Fig. 7 is a view in side elevation of the thermal retarder with the cover shown in section.

Fig. 8 is a view in front elevation thereof, with the cover shown in section,

Fig. 9 is a top plan view of a modified form of thermal retarder shown in Figs. 10 and 11, with the cover shown in section,

Fig. 10 is a view in side elevation of a second form of thermal retarder.

Fig. 11 is a view in front elevation of the device shown in Figs. 9 and 10, and

Fig. 12 is an extended plan view of the thermal element shown in Fig. 10 of the drawings.

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Referring first of all to Fig. 1 of the drawings I have there shown an ordinary domestic hot water tank 21 having a lower cold water inlet pipe 23, an upper hot water outlet pipe 25, and having also a mass 27 of heat-insulating material located therearound, which mass is held in proper operative position around the tank 21 as by an outside casing 29.

I provide preferably, but not necessarily, a single electric heater 31, which, if only a single electric heater is provided, is located adjacent to the lower end portion of the tank 21 and may be located in a tunnel member 33. All of the hereinbefore described elements of an electric hot water heater are old and well known in the art and constitute no part of my present invention.

I provide a lower thermally-actuable heater control switch designated in its entirety by numeral 35, and here also the showing is general only, since any other thermally-actuable switch structure effective for the same purpose may be used in place thereof. I have illustrated the thermally-actuable switch 35 as comprising a bimetal bar 37, which has one end mounted on a contact 39, while the other end is adapted to engage another contact 41, which contacts are insulatedly mounted on tank 21 adjacent the lower end thereof. The design, construction, and adjustment of the thermally-actuable switch 35 is such that the bimetal bar 37 will be in closed position, that is in engagement with contact 41, when subject to cold water in the tank, and will be out of engagement therewith when subject to hot water. When I speak of cold water, I refer to water the temperature of which is on the order of 60° to 70° F., and when I speak of hot water I refer to water the temperature of which is on the order of 150° F., or slightly higher.

I provide further a thermal retarder designated generally by numeral 43 and prefer to locate this thermal retarder heater control switch unit in heat-receiving relation on the tank at about one-half of the height thereof.

Referring now to Figs. 5 to 8 inclusive, I have there illustrated the details of construction and mounting of the thermal retarder 43. I provide a supporting block 45, whch is made of heat-conducting material, and the inner surface of which is of arcuate shape so that substantially the entire inner surface of the block will be in engagement with the outer surface of tank 21, and in order to hold member 45 in proper operative position, I may use a plurality of welding seams 47.

I provide further a supporting bracket 49, which is of substantially L-shape and which has

its vertically-extending portion secured against support 45 as by machine screws 51. The front surface of the vertically-extending portion of member 49 is provided with a projecting portion 52, which has secured to it the two side portions of a bracket 53, which side portions may be secured in proper operative position against portion 52 as by short machine screws 55.

I provide a block 57 of electric-insulating material which is secured against the side pieces 53 as by a plurality of small machine screws 59, a permanent horseshoe magnet 61 being also secured in proper operative position, as shown particularly in Fig. 7 of the drawings, by the machine screws 59. The block 57 has two recesses 63 and 65 in its upper surface to receive parts of the switching means. The portions of block 57 between the recesses 63 and 65 and at the right of recess 65 (as seen in Fig. 7) are provided with aligned openings therethrough to receive an actuating rod 67 which is adapted to be moved by a relatively long creep-type bimetal bar 69 having its lower end mounted on projection 52 as by a machine screw 71. The upper end of bimetal bar 69 may be made of U-shape to fit into the reduced end portion of rod 67, a pair of enlarged flanges 73 being provided.

The end portions of the permanent magnet 61 extend vertically upwardly, as shown particularly in Fig. 7 of the drawings, and a magnetic keeper 75 is fixedly mounted on rod 67 so that it will be in engagement with the vertical end portions of magnet 61 when the bimetal bar 69 is subject to cold water in the tank. I provide further a contact bridging member 77, supported by a collar 78 of electric-insulating material, on rod 67, which bridging member is positioned in recess 65 and is adapted to engage with and be disengaged from two fixed contacts 79 and 81 supported by block 57. Contact bridging member 77 is biased to the left as by a spring 83 positioned between bridging member 77 and a collar 85 fixedly mounted on rod 67. A second coil spring 87 is also mounted on rod 67 and extends to the right of collar 85 and against a screw bearing 89 which has screw-threaded engagement in an opening in the right hand portion of member 57. Contact member 79 has a second contact member 91 electrically connected therewith and positioned at the left hand side of the outer end portion of member 57, while contact member 81 has electrically connected therewith a contact member 93 also positioned at the left hand side of the outer end portion of member 57 so that the contact bridging member 77 may operatively engage contact members 79 and 81 or contact members 91 and 93 in accordance with the position of the bimetal bar 69.

I provide a small heating coil 95 on the upper end of bimetal bar 69 so that while the lower end portion of the bimetal bar 69 is subject to the temperature of water in the tank, the upper end portion thereof is controlled particularly by the heating coil 95. A casing 96 is provided for the parts above described.

Bimetal bar 69 is shown, in full lines in Fig. 7, in the position which it will occupy when subject to cold water in the tank, so that contact bridging member 77 will be in engagement with contacts 79 and 81, and keeper 75 will be in engagement with permanent magnet 61.

When bimetal bar 69 is subject to hot water in the tank, the contact bridging member 77 is out of engagement with either pair of fixed contacts, and when heating coil 95 has been energized for

say four hours, the bimetal bar 69 will have flexed in a clockwise direction to the position shown in broken lines and bridging member 77 will be in engagement with fixed contacts 91 and 93. The temperature of the free end of bimetal bar 69 will be on the order of 200° to 250° F. at this time.

Referring now to Figs. 2 and 3 of the drawings, I have there illustrated a diagram of connections of the assembled system, of which my just above described thermal retarder heater control switch unit is a part. I have shown a time-controlled switch designated generally by numeral 97 and comprising a pair of contact arms 99 and 101. Contact arms 99 and 101 are designed and constructed to be out of engagement with each other during all on-peak periods of a twenty-four hour day, while they are to be in engagement with each other during off-peak periods of a twenty-four hour day, being controlled by a continuously-operative timer of any desired kind.

I provide a pair of supply circuit conductors 103 and 105, of which conductor 103 is connected with arm 99. Contact arm 101 is connected with fixed contact 93 by a conductor 107, and as has already been hereinbefore stated, contact 93 is electrically connected with contact 81. Contact 81 is connected by a conductor 109 with one terminal of heating coil 95, the other terminal of which is connected by a conductor 111 with contact 41 of the lower thermal switch 35. Contact 39 of lower thermal switch 35 is connected by a conductor 113 with the second supply circuit conductor 105. Contact 79 is connected by a conductor 115 to one terminal of heater 31, the other terminal of which is connected by a conductor 117 with contact 41 of the lower thermally-actuable switch 35.

Referring now particularly to Fig. 2 of the drawings, I have there shown the parts in the positions they will occupy when the tank is filled with cold water or is at least more than half full of cold water, and with the time switch in open position, as during on-peak periods. Bimetal bar 69 will have flexed to the position shown in full lines so that contact bridging member 77 is in engagement with contacts 79 and 81 by reason of the movement of rod 67 to the left compressing spring 83. Keeper 75 will also be in engagement with magnet 61, as shown in Figs. 5 and 7. As soon as closure of the time-controlled switch 97 occurs, as at the start of an off-peak period, say 10 p. m., energization of the heater 31 will occur through a circuit as follows: from supply circuit conductor 103, engaged contact arms 99 and 101, conductor 107, to contacts 93 and 81, through contact bridging member 77, to contact 79, through conductor 115, heater 31, conductor 117, through closed switch 35, and then through conductor 113 to the second supply circuit conductor 105. This will cause energization of heater 31 and heating up of the upper end portion of the cold water in the tank, with the result that at the end of say one or two hours, sufficient hot water has been heated to the predetermined temperature of 150° or over to subject the thermal retarder unit to hot water, causing flexure in a clockwise direction of bimetal bar 69, with the result that contact bridging member 77 will be moved out of engagement with contacts 79 and 81. The difference in temperature between hot and cold water is 90° to 80° F., which is a rather large change of temperature to which the bimetal bar 69 is subjected. The bimetal bar will tend to flex in a clockwise direction with any increase of temperature of the

water in the tank, but the action of the keeper 75 with the permanent magnet 61 will hold the contact bridging member 77 in engagement with fixed contacts 79 and 81 until the temperature of bimetal bar 69 is substantially 150°, when quick movement of the contact bridging member 77 out of engagement with contacts 79 and 81 will occur, whereby the heater 31 is deenergized.

At the same time an energizing circuit through the small heating coil 95 was closed as follows: from supply circuit conductor 103, through engaged contact arms 99 and 101, conductor 107, contacts 93 and 81, conductor 109, coil 95, conductor 111, through closed switch 35, and from there through conductor 113 to the second supply circuit conductor 105. Energization of heating coil 95 is therefore controlled jointly by the time-controlled switch 97 and the lower thermally-actuable heater control switch 35. The electric energy translated into heat in heating coil 95 is such that it will require from four to six hours to cause temperature rise of particularly the upper end portion of bimetal bar 69 to cause full flexure of that part thereof in a clockwise direction and engagement of bridging member 77 with the second pair of contacts 91 and 93 causing reclosure of the energizing circuit through heater 31 substantially as hereinbefore described with the sole exception that contact bridging member is now in engagement with contacts 91 and 93, instead of with contacts 79 and 81.

Heating coil 95 was energized at the same time as was electric heater 31 and caused a small increase in temperature of the outer free end of bar 69 in the one or two hours it will require to heat the water in the upper part of the tank or until the thermal retarder is subject to hot water. The adjustment of the thermal retarder unit is such that interruption of the energizing circuit of heater 31 will occur shortly after the thermal retarder is subject to hot water in the tank. The reenergization of heater 31 will therefore take place in from two to three hours after it was first deenergized and will continue until substantially all of the water in the tank is hot, at which time, assuming that this occurs before opening of the time-controlled switch takes place, the lower thermally-actuable switch 35 will move to open position, whereby heater 31 is deenergized.

Let it now be assumed that the amount of hot water withdrawn from the tank during on-peak periods was less, so that only the lower thermally-actuable switch 35 was subject to cold water and the parts of the thermal retarder were in the positions shown in Figs. 3 and 6. In this case, when the time-controlled switch 97 was closed, the hereinbefore described energizing circuit through heating coil 95 was closed immediately upon closure of the time-controlled switch 97, with the result that, in say four hours, after the start of an off-peak period, bimetal bar 69 will have been flexed in a clockwise direction from the position shown in Fig. 3 of the drawings, so that contact bridging member 77 will be moved into engagement with contacts 91 and 93, whereupon the hereinbefore described energizing circuit through heater 31 will be closed, this energization continuing until substantially all of the water in the tank is hot, when thermally-actuable switch 35 will open the circuit, if this occurs before opening of the time-controlled switch.

The above described interruption of the circuit by the lower thermally-actuable switch 35 may, however, not occur, deenergization of heater 31 being effected by the opening of the time-controlled switch 97 at the end of an off-peak period in case less than substantially all of the water in the tank is hot by that time.

Referring now to Figs. 9 to 12, I have there illustrated a modification of a thermal retarder heater control switch unit slightly different than the device shown in Figs. 5 to 8 inclusive. I provide a heat-conducting supporting block 121, which is provided with an arcuate inner surface so that all of this surface will be in heat-conducting engagement with the outer surface of tank 21, and block 121 may be secured and held in proper operative position as by welding seams 123. I provide a bracket 125, which may be of substantially L-shape, with its vertical portion held as by short machine screws 127 against block 121.

I provide a creep-type bimetal bar 129, which is normally of substantially U-shape and mounted against a front projecting portion 131 of bracket 125 as by a bar 133 held by machine screws 135 against projection 131. The high-expansion component of bimetal bar 129 is upon the inside of the bar when bent to U-shape, and I provide a central portion 137 of reduced area at substantially the middle of the length of bimetal bar 129 and support the bar against projection 131 adjacent to portion 137 by the inner end portion of bimetal bar 129.

I provide a resilient bar 139, which is secured to the upper end of the inner portion of bimetal bar 129, and mount thereon a contact bridging member 141, a sheet 143 of electric-insulating material being provided to properly electrically insulate the contact bridging member 141 from bar 139. Contact bridging member 141 is adapted to engage with and be disengaged from a pair of spaced fixed contacts 145 and 147, which are mounted on a block 149 of electric-insulating material, which is held by a supporting bracket 151, which is secured against the upper end portion of bracket 125 as by machine screws 153.

The second outer end portion of bimetal bar 129 has insulatedly mounted thereon, adjacent its outer free end portion, a heating coil 155, the amount of energy translated therein into heat being such that the temperature rise, on the order of 200° F. to 250° F., to cause flexure in a clockwise direction sufficient to cause a contact bridging member carried thereby to engage fixed contact members, will require from four to six hours. The portion 137 of reduced area of cross section tends to prevent or retard the flow of heat from the one to the other end portion of bimetal bar 129. A resilient bar 157 is secured to the outer end of the outer portion of bimetal bar 129 and has insulatedly mounted thereon a contact bridging member 159, which is adapted to engage with and be disengaged from a second pair of fixed contacts 161 and 163, which are respectively electrically connected with contact members 145 and 147 hereinbefore described. A cover 164 is also provided.

Referring now to Fig. 4 of the drawings, I have there illustrated a diagram of connections of an electric circuit embodying the thermal retarder switch unit shown in Figs. 9 to 12 inclusive. The parts are shown in Fig. 4 of the drawings, as when the tank is slightly more than half full of cold water, when the left hand or inner portion of bimetal bar 129 will be in position to cause contact bridging member 141 to engage contacts 145 and 149 to cause energization of the heater 31 through a circuit as follows: from supply circuit conductor 103, through closed time switch 97, a conductor 165 to contact 149, through bridging

member 141 to contact 145, through a conductor 167 to heater 31, through a conductor 117 to the closed lower thermally-actuable switch 35, and from there through conductor 113 to the other supply circuit conductor 105. This energizing circuit will be established by the closing of time switch 97, and energization of the heater 31 will continue until substantially one-half of the water in the tank is hot, which will require from one to two hours.

Energization of heating coil 155 began also with the closing of time switch 97, and this energization continued irrespective of deenergization of heater 31 as above described. In about four hours the temperature of the outer or right hand portion of bar 129 will have reached a value on the order of 200° to 250° F., causing flexure of this portion in a clockwise direction and engagement of bridging member 159 with contacts 161 and 163, whereby heater 31 is reenergized through a circuit as follows: from supply circuit conductor 103, through closed switch 97, conductor 165, contact 163, bridging member 159, contact 161, conductor 167, heater 31, conductor 117, closed switch 35 and through conductor 113 to the other supply circuit conductor 105. This energization will continue until substantially all of the water in the tank is hot, when switch 35 will open, that is, if all of the water is hot before the end of an off-peak period. If less than all of the water in the tank is hot by the end of the off-peak period, the heater and system will be deenergized by opening of the time switch.

In case only a relatively small amount of hot water was withdrawn from the tank during on-peak periods, so that the bimetal bar 129 of the thermal retarder unit was subject to hot water in the tank, with the result that contact bridging member 141 was out of engagement with contacts 145 and 149, then an energizing circuit through heating coil 155 will be established at the start of an off-peak period as follows: from supply circuit conductor 103 through closed switch 97, conductor 165 to contact 163, through a conductor 169, heating coil 155, conductor 171, to closed lower thermal switch 35, and from there through conductor 113 to the second supply circuit conductor 105. The heating coil 155 thus energized, will cause flexure of the second or outer end portion of bimetal bar 129 in a clockwise direction, so that when a predetermined high temperature, on the order of 200° to 250° F., has been reached, the outer end portion of bimetal bar 129 will have flexed enough to cause engagement of contact bridging member 159 with contacts 161 and 163, whereby an energizing circuit through heater 31 is established, including contact bridging member 159 and engaged contacts 161 and 163. Energization of heater 31 will continue until substantially all of the water in the tank is hot, assuming that all of it will be heated before opening of the time-controlled switch 97, when lower thermally-actuable switch 35 will move to open position and deenergize the heater 31. If, for any reason, less than all of the water in the tank is hot by the end of an off-peak period, then heater 31 will be deenergized by opening of the time-controlled switch 97.

The thermal retarder shown in two forms is therefore effective to selectively cause either immediate energization of an electric heater for a hot water tank upon closure of a time-controlled switch, or with a predetermined time period of delay after closure of a time-controlled switch, in accordance with the amount of hot water in the tank at the time of closure of the time-controlled switch.

The use of permanent magnet 61 and spring 87 permits of holding the contact bridging member 77 in engagement with fixed contacts 79 and 81 until the temperature of bimetal bar is on the order of 150° F. and to hold it out of engagement with fixed contacts 91 and 93 until the temperature of bimetal bar is on the order of 250° F. The use of the spring bars 139 and 157 serves the same purpose, namely that of ensuring engagement and disengagement of the contact bridging members with the fixed contacts at the desired temperatures. The permanent magnet is also effective to cause a quick break between bridging member 77 and contacts 79 and 81. The tension of spring 87 may be varied by screw bearing 89, to permit of manual adjustment of the time element in which bridging member 77 engages contacts 91 and 93, as well as of the temperature at which such engagement occurs.

Various modifications may be made in the device embodying my invention, and all such modifications clearly coming within the scope of the appended claims shall be considered as being covered thereby.

I claim as my invention:

1. A thermal retarder switch unit for a hot water tank heater, comprising a tank, a bimetal bar, one end portion of which is adapted to be mounted in heat-receiving relation on a tank, a heating coil mounted on the other end portion of said bimetal bar, switching means including a pair of fixed, spaced, electrically-connected contacts, the bimetal bar closing a heater-energizing circuit through the first of said fixed contacts when subject to cold water in the tank, opening said heater-energizing circuit when subject to hot water in the tank and when the heating coil is unenergized and closing a heater-energizing circuit through the other fixed contact when the bar is subject to hot water in the tank and the heating coil has been energized for at least a predetermined period of time.

2. A thermal retarder switch unit for controlling a hot water storage tank heater circuit, comprising a circuit including a bimetal bar having one end portion adapted to be mounted in heat-receiving relation on a tank, a heating coil mounted on the other end portion of said bimetal bar, contact members carried by and actuable by said bimetal bar and a plurality of fixed, spaced, electrically-connected contacts in said circuit, the bimetal bar effecting closure of said circuit through the first of said fixed contacts when subject to cold water in a tank, effecting opening of said circuit when subject to hot water in a tank and when said heating coil has been energized for less than a predetermined period of time and effecting reclosure of said circuit when subject to hot water in a tank and when said heating coil has been energized for at least a predetermined period of time.

3. A thermal retarder switch unit for a hot water storage tank heater circuit, comprising a circuit including a bimetal bar, one end portion of which is mounted in heat-exchanging relation on a tank, a heating coil on the other end portion of said bimetal bar and a plurality of cooperating fixed contact members in said circuit, the bimetal bar closing said circuit through certain of said contact members when subject to cold water in a tank, disengaging said certain contact members when subject to hot water in

a tank and reclosing said circuit through other of said contact members when said heating coil has been energized for a predetermined length of time.

4. A thermal retarder heater control switch unit for a hot water storage tank heater, comprising a bimetal bar of substantially U-shape, a supporting block of heat-conducting material secured to one end portion of said bar and adapted to be secured in heat-receiving relation on a tank, a heating coil for the other end portion of said bimetal bar and means for reducing the flow of heat between the two end portions of said bimetal bar.

5. A thermal retarder heater control switch unit for a hot water storage tank heater, comprising a bimetal bar of substantially U-shape, a supporting block of heat-conducting material secured to one end portion of said bar and adapted to be secured in heat-receiving relation on a tank, a heating coil for the other end portion of said bimetal bar, the intermediate part of said bar being of reduced area of cross-section to reduce the flow of heat between the end portions of the bar.

6. A thermal retarder switch unit for a hot water storage tank heater, comprising in combination with a tank a creep-type bimetal bar, means for connecting one end portion of said bar for heat exchange with water in the tank, a heating coil mounted on the other end portion of said bar, contact members carried by the ends of said bar and a plurality of fixed, spaced, electrically-connected contacts adapted to be selectively engaged by the respective contact members carried by the ends of said bar in predetermined sequence in accordance with the temperature of said ends of the bar.

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