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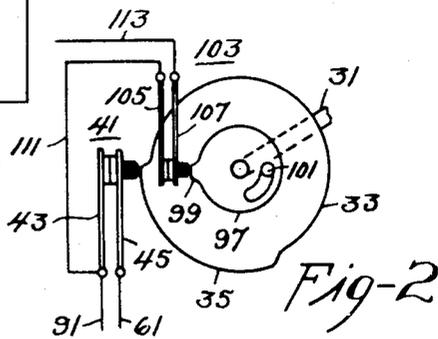
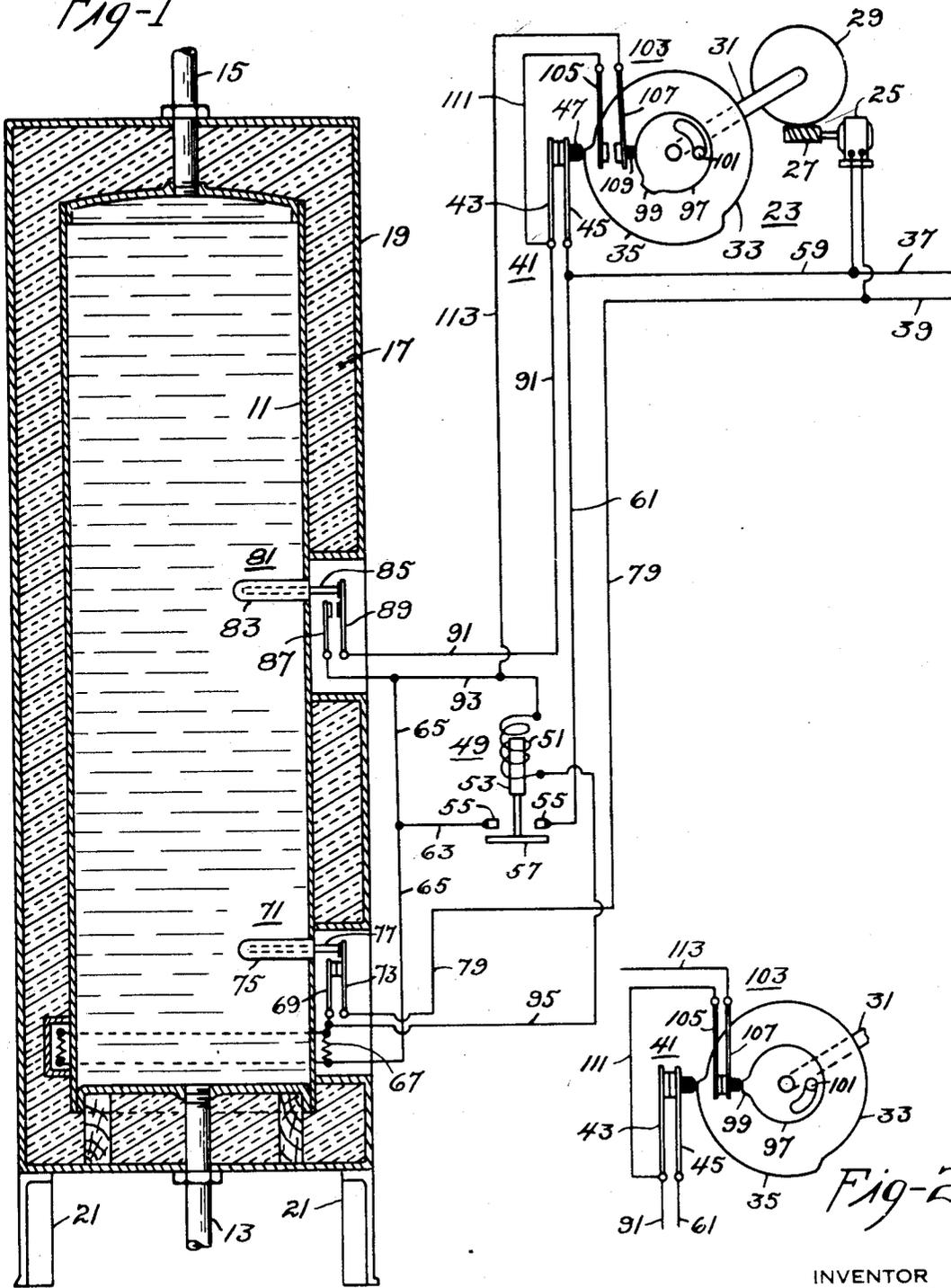
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2,266,232

OFF-PEAK WATER HEATING SYSTEM

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Fig-1



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OFF-PEAK WATER HEATING SYSTEM

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11 Claims. (Cl. 219-39)

My invention relates to hot water tanks and more particularly to off-peak water heating systems for use with such hot water tanks.

One of the objects of my invention is to provide a relatively simple off-peak water heating system embodying a minimum number of control elements.

Another object of my invention is to provide an off-peak water heating system embodying means for ensuring starting of the heating of the water at the start of an off-peak period if the tank contains less than a given quantity of hot water and for delaying starting of the heating, after the start of an off-peak period, in case the tank contains more than a predetermined amount of hot water at the start of an off-peak period.

Another object of my invention is to provide an off-peak water heating system which will continue heating of the water in the tank in case the tank is not full of hot water at the end of an off-peak period.

Other objects of my invention will either be evident from a description of one system embodying my invention or will be pointed out in the course of such description and will be more particularly pointed out in the appended claims.

In the single sheet of drawings,

Figure 1 is a view showing a hot water tank in vertical section, certain control elements mounted thereon and other parts of a system embodying my invention, and,

Fig. 2 is a fragmentary view of a part of a timing device constituting a part of my system.

I have illustrated a hot water tank 11 which is shown as of elongated cylindrical shape to indicate the ordinary hot water tank used in domestic heating. This tank includes a cold water inlet pipe 13 and a hot water outlet pipe 15. The tank may be surrounded with heat insulating material 17 which may be covered by an outer thin sheet metal casing 19, the whole assembly being supported by a plurality of legs 21. It is to be understood that while I have illustrated a specific form of hot water tank, my invention is not limited thereto and the tank and closely associated parts are shown merely for illustrative purposes.

I provide a continuously operative timing means 23 which includes an electric motor 25 having a worm gear 27 mounted on its shaft which worm gear is adapted to mesh with and to cause rotation of a circular disc 29. This disc 29 is mounted on a shaft 31 and while I have not illustrated any bearings for this shaft, these are

to be understood as being provided. I desire further to point out that while I have illustrated a continuously operative timing device generally only, I do not desire to be limited to the specific details shown since I may use similar forms of continuously operative timing devices now well known in the art. It is to be understood that the electric motor 25 is operative to cause one complete rotation of disc 29 and shaft 31 in a twenty-four hour day.

I provide a cam disc 33 mounted on the shaft 31 and the greater part of the periphery of disc 33 is of uniform outer radius. A predetermined portion of the peripheral extent of disc 33 is of slightly larger diameter and this portion is designated by the numeral 35.

The peripheral extent of portion 35 is that decided upon by the public service station or utility providing electric current as being the off-peak period, during which they will provide electric current at rates less than those in effect during the rest of a twenty-four hour day. It will be noted that I have illustrated the peripheral extent of portion 35 as being substantially one-third of the total periphery, that is, it covers or corresponds to an eight-hour off-peak period. For illustrative purposes it may be noted that the off-peak period may extend from 10:00 p. m. to 6:00 a. m. I do not desire to be limited to this particular length of off-peak period nor to the hour of starting and of ending thereof but, as hereinbefore noted, these are given by way of example. It will be noted further that the timing device is shown in the position in which certain parts thereof will be located at the start of an off-peak period, say at 10:00 p. m.

The electric motor 25 is energized from a supply circuit including conductors 37 and 39.

I provide a mechanically actuated control switch 41 including a relatively rigid contact arm 43 and a resilient contact arm 45 which is normally biased out of engagement with arm 43 but is moved into engagement therewith when a lug 47 on arm 45, which may be of electric-insulating material, is engaged with the outer surface of portion 35 of disc 33.

I provide a single electromagnetic contactor 49 which includes in addition to a coil 51, an electromagnetic armature core 53, a pair of spaced fixed contact members 55 and a movable contact bridging member 57, all in a manner now well known in the art of electric circuit control.

Supply circuit conductor 37 is connected through a conductor 59 with contact arm 45 and a conductor 61 connects conductor 59 with one

of the fixed contact members 55. The other fixed contact member 55 is connected through a conductor 63 and a conductor 65 with one terminal of an electric heater 67 associated with the tank 11. The other terminal of the heater is connected to a substantially rigid contact arm 69 of a thermally actuatable switch 71. The switch 71 includes a second substantially resilient contact arm 73 and a tubular member 75 suitably secured to the wall of the tank 11 to be positioned inside of the tank. Arm 73 is normally yieldingly biased into engagement with contact arm 69. The switch includes also an expansion rod 77 which is adapted to cause movement of contact arm 73 away from contact arm 69 when the tubular member 75 is surrounded by hot water or by water having a given temperature. While I have shown a particular form of thermally-actuatable switch I do not desire to be limited thereto as any other form of thermally-actuatable switch operative for the same purpose may be used.

Contact arm 73 of switch 71 is connected through a conductor 79 to the other supply circuit 39. It may be here pointed out that when contact bridging member 57 is in engagement with the cooperating fixed contact members 55 and in case tubular member 75 of the main thermally actuatable switch 71 is surrounded by cold water, energization of the heating element 67 will be effected by a circuit substantially as follows: From supply circuit conductor 37 through conductors 59 and 61, contact members 55 and 57, conductors 63 and 65 to heater 67, through contact arms 69 and 73 of switch 71 and through conductor 79 to the other supply circuit conductor 39.

I provide further an auxiliary thermally actuatable switch 81 comprising a tubular member 83, a thermally expansible rod 85 therein, a relatively rigid contact arm 87 and a resilient contact arm 89 engaged by rod 85 and moved thereby into and out of engagement with contact arm 87, the two contact arms 87 and 89 being out of engagement as shown in Fig. 1 of the drawing when tubular member 83 is surrounded by hot water.

Contact arm 43 of switch 41 is connected by a conductor 91 to contact arm 89 while contact arm 87 is connected to conductor 65 and to one terminal of coil 51 by a conductor 93. The other terminal of coil 51 is connected through a conductor 95 to contact arm 69 of main thermal switch 71.

Let it be assumed that with the parts hereinbefore described in the positions shown in Fig. 1 of the drawing, that is, the contact arms of switch 41 have been moved into engagement and the quantity of hot water in the tank is sufficient to envelope the tube 83 with hot water, in which case contact arm 89 is out of engagement with contact arm 87. In this case energization of the coil 51 will not occur at the start of an off-peak period since the energizing circuit for this coil is substantially as follows: From supply circuit conductor 37 through conductor 59, contact arms 45 and 43, conductor 91, contact arms 89 and 87 (when in engagement with each other) conductor 93, coil 51 and through conductor 95, switch 71 and conductor 79 to the other supply circuit conductor 39. As was hereinbefore stated, contact arms 89 and 87 are out of engagement with each other when tubular member 83 is surrounded by hot water, hence this coil energizing circuit will not be closed.

If, on the other hand, the amount of hot water 75

in the tank at the start of an off-peak period is so small that tubular member 83 is surrounded by cold water, with attendant contact between arms 89 and 87, then the above described energizing circuit through coil 51 will be closed at the start of an off-peak period when the timing device has moved contact arm 45 into engagement with contact arm 43. This will, of course, result in heating of the water in the tank.

I may here point out that in case the amount of hot water in the tank at the start of an off-peak period was sufficient to envelope the tubular member 83 and to delay energization of the heater 67 and if withdrawal of hot water should occur during the delay period to such an amount as to envelope tubular member 83 in cold water, closure of the energizing circuit of coil 51 would occur as soon as contact arms 89 and 87 engaged each other, so that the heater 67 would be energized.

It is desired to cause energization of the coil 51 of the contactor at a predetermined later time after the start of an off-peak period if all of the water in the tank is not hot and for this purpose I provide an auxiliary cam disc 97 on shaft 31 adjacent to disc 33, which cam disc 97 is provided with a small ear or lug 99 of slightly larger radius than the main part of the periphery of disc 97. I provide means including a stop pin 101 which may be mounted on cam disc 33 to permit of adjusting disc 97 on shaft 31 to any desired position intermediate that shown in Fig. 2 of the drawing and that shown in Fig. 1 of the drawing. It is to be understood that while I have shown a rather large peripheral extent of lug 99, this may be made relatively small since it is necessary to make momentary contact only as will now be described, of an auxiliary control switch.

This auxiliary control switch 103 includes a relatively rigid contact arm 105 and a resilient contact arm 107 normally biased out of engagement with arm 105 so that a lug 109 of electric insulating material on arm 107 may rest on the periphery of cam disc 97. Contact arm 43 is connected through a conductor 113 with conductor 93. If the quantity of hot water in the tank 11 was such that tubular member 83 was surrounded by hot water and the switch contacts 87 and 89 were out of engagement with each other at the start of an off-peak period, and if cam disc 97 was set on its shaft 31 so that lug 99 thereon would engage member 109 after two hours delay, the engagement of contact arm 107 with contact arm 105 would cause closure of the following energizing circuit through coil 51: From supply circuit conductor 37 through conductor 59, engaged contact arms 45 and 43, conductor 111, engaged contact arms 105 and 107, conductor 113, part of conductor 93, coil 51, conductor 95, switch 71 and conductor 79 to the other supply circuit conductor 39. In other words, the cam disc 97 is effective to cause closure of the contactor and closure of the energizing circuit through the heater 67 at the time that contact arms 105 and 107 are in engagement provided that the tank is not entirely full of hot water, that is, contact arm 73 is out of engagement with contact arm 69.

It is thus obvious that in case the quantity of hot water in the tank at the start of an off-peak period is more than a predetermined amount, energization of the heating element will be delayed an adjustably predetermined time after the start of an off-peak period, so long as there

was an appreciable amount of cold water still in the tank, which amount of cold water would, of course, be located in the lower part of the tank.

It has hereinbefore been stated that the engagement between contact arms 105 and 107 need be momentary only and the holding circuit for continuing the energization of the coil 51 will now be pointed out. Starting from supply circuit conductor 37 and extending through conductors 59 and 61, through the contact members 55 and 57 of contactor 49, conductors 63, 65 and 93 through coil 51, through conductor 95, contact arms 69 and 73 of thermal switch 71 and through conductor 79 to the other supply circuit conductor 39. It is evident that this holding circuit, once established, is not dependent upon either switch 41 or 103.

Deenergization of the heater 67 will be effected when all of the water in the tank has been heated to a predetermined temperature because of the action of the main thermally actuatable switch 71 in causing disengagement of contact arm 73 from contact arm 69 with resultant opening of the circuit through the heater 67. If all of the water in the tank should happen to have been heated to a predetermined temperature during the off-peak period, the heater will be deenergized by reason of the opening of the switch 71 because of the movement of contact arm 73 out of engagement with contact arm 69. This will also interrupt the hereinbefore described holding circuit for coil 51 so that contactor 49 will also open. Should this condition of the tank being filled with hot water occur during an off-peak period and should withdrawal of hot water occur during the rest of that off-peak period, the heater will be again energized as hereinbefore set forth and should, for example, rapid withdrawals of hot water occur during the rest of the off-peak period with the result that all of the water in the tank is not hot at the end of an off-peak period, the energization of heater 67 will be continued beyond the end of the off-peak period and will actually continue until all of the water in the tank has been heated to a predetermined temperature when the hereinbefore described operation of the main thermal switch 71 will cause deenergization of the heater and it may be noted that it will thereafter be impossible to reenergize the heater until the start of the next following off-peak period.

The positions of certain parts of the timing device shown in Fig. 2 are those which will cause starting of the energization of the heater 67 at the beginning of an off-peak period irrespective of whether the auxiliary thermally actuatable switch is subjected to hot water or to cold water. The user of my improved water heating system may thus easily and quickly meet unexpected operating conditions and start an on-peak part of the day with a desired quantity of hot water.

It may be noted that the system embodying my invention utilizes a single electromagnetic contactor in combination with a main thermally actuatable heater control switch, the two being connected in series circuit relation relatively to each other, to control the energization of an electric heater and energization of the heater may start with the start of an off-peak period under certain conditions as to the quantity of hot water in the tank at the start of the off-peak period, or the energization of the heater may be delayed a predetermined adjustable time and if the heater is deenergized during the off-peak

period because of the tank being full of hot water and withdrawals of hot water occur during the rest of the off-peak period, the heater will be again energized, which energization will continue beyond the end of the off-peak period in case all of the water in the tank is not hot at the end of an off-peak period. I may also point out that in case the tank contained enough hot water at the start of an off-peak period to delay energization of the heater and withdrawal of hot water occurred during such delay period to an extent to subject thermally actuatable switch 81 to cold water, energization of coil 51 of contactor 49 would occur since contact arms 89 and 87 would move into engagement with each other under those conditions, with resultant engagement of contact bridging member 57 with fixed contact members 55. This would energize the electric heater 67.

While I have shown the auxiliary thermal switch subject to tank water temperature as being located substantially midway of the axial length of the tank, I do not desire to be limited thereto as it may be located in or on the tank at any other desired point, say at one-third or at two-thirds of the tank height and the amount of hot water in the upper part of the tank necessary to cause opening of this switch will vary substantially in accordance with the location of this switch. The cooperative positions of the electric heater and of the lower thermal heater control switch are such that this thermal switch will not open until substantially all of the water in the tank is hot, that is, has been heated to a desired high temperature.

While I have illustrated and described a specific embodiment of water heating system embodying my invention, it is obvious that modifications may be made therein 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. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, time and temperature responsive switches jointly controlling said electromagnetic switch to cause energization of said heater at the start of an off-peak period when the tank contains more than a predetermined quantity of cold water at the start of the off-peak period, to delay for a fixed length of time after the start of an off-peak period the energization of said heater when the tank contains less than said predetermined quantity of cold water at the start of the off-peak period and to cause continuance of the energization of the electric heater beyond the off-peak period in case the tank contains an appreciable quantity of cold water at the end of the off-peak period, said energization continuing until substantially all of the water in the tank is hot.

2. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, a plurality of switches controlled respectively by time and by tank water temperature jointly controlling said electromagnetic switch to delay energization of said heater a fixed length of time after start of an off-peak period in case less than a predetermined amount of cold water is in the tank at the start of the off-peak period and during said delay, to cause energization of

the heater during said delay time in case withdrawals of hot water from the tank cause it to contain more than said predetermined amount of cold water, to cause prolongation of the energization of the heater beyond the end of the off-peak period in case more than a lesser predetermined amount of cold water is in the tank at the end of the off-peak period and to cause deenergization of the heater when substantially all of the water in the tank is hot.

3. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, a plurality of switches controlled respectively by time and by tank water temperature jointly controlling said electromagnetic switch to cause it to energize said heater at the start of an off-peak period when the tank contains more than a predetermined quantity of cold water at the start of an off-peak period, to prolong the energization of the heater beyond the end of the off-peak period in case the tank contains an appreciable quantity of cold water at the end of the off-peak period, to deenergize the heater when all of the water in the tank is hot and to reenergize the heater after such deenergization in case withdrawals of hot water from the tank after such deenergization during the off-peak period cause it to contain an appreciable quantity of cold water.

4. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch controlling said heater, a plurality of switches controlled respectively by time and by tank water temperature jointly controlling said electromagnetic switch to delay energization of said heater a fixed length of time after start of an off-peak period in case less than a predetermined amount of cold water is in the tank at the start of the off-peak period, to cause heater energization during that time in case withdrawals of hot water from the tank causes the tank to contain more than said predetermined amount of cold water, to cause deenergization of the heater at any time during the rest of the off-peak period when all of the water in the tank is hot and to reenergize said heater at any time during the rest of the off-peak period after its deenergization in case withdrawals of hot water from the tank cause the tank to contain an appreciable quantity of cold water.

5. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, time and tank water temperature responsive switches jointly controlling the closure of said electromagnetic switch at a predetermined time of day when a predetermined amount of cold water is in the tank and a second tank water temperature responsive switch for the electric heater effective to cause deenergization of said heater when substantially all of the water in the tank has been heated to a predetermined temperature.

6. An off-peak water heating system for a hot water tank comprising a single electric heater located adjacent to the bottom of the tank, an electromagnetic switch for said heater, a main thermally-actuable switch subject to the tank water temperature in series circuit relation with said electromagnetic switch for said heater and effective to cause deenergization of said electric heater when substantially all of the water in the tank has been heated to a predetermined temperature, an auxiliary thermally-actuable

switch subject to the temperature of the water at an elevated part of the tank, a normally open switch in series circuit relation with said auxiliary thermally-actuable switch, a continuously-operative timer adapted to cause closure of said normally-open switch at the beginning of an off-peak period, said auxiliary thermally-actuable switch and said timer-controlled switch being jointly effective to cause closure of said electromagnetic switch and energization of said electric heater on closure of said timer-controlled switch and on presence of such an amount of cold water in the tank as to affect said auxiliary thermally-actuable switch, said main thermally-actuable switch being effective to cause deenergization of the electric heater when substantially all of the water in the tank has been heated thereby to a given temperature.

7. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, a main thermally-actuable switch in series circuit relation with said electromagnetic switch for said heater and effective to cause deenergization of said electric heater when substantially all of the water in the tank has been heated to a predetermined temperature, an auxiliary thermally-actuable switch subject to the temperature of the water at an elevated part of the tank, a normally-open switch in series circuit relation with said auxiliary thermally-actuable switch, a continuously operative timer adapted to cause closure of said normally-open switch at the beginning of an off-peak period, said auxiliary thermally-actuable switch and said timer-controlled switch being jointly effective to prevent closure of said electromagnetic switch and energization of said electric heater on closure of said timer-controlled switch and on presence of such an amount of hot water in the tank as to affect said auxiliary thermally-actuable switch and a manually-adjustable second time-controlled switch jointly effective with said first named timer-controlled switch to cause closure of said electromagnetic switch after an adjustably preset time interval after closure of said first named timer-controlled switch.

8. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic switch for said heater, time and tank water temperature controlled switches jointly effective to cause closure of said electromagnetic switch and energization of said heater at a time after closure of the time-controlled switch varying with the amount of hot water in the tank and thermally-actuable switching means for causing deenergization of said heater when all of the water in the tank is hot irrespective of the operative position of the time-controlled switch.

9. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic heater control switch, a thermal heater control switch for deenergizing said heater when substantially all of the water in the tank is hot, a first normally open switch, a second thermal switch subject to tank water temperature, a second normally open switch, a continuously operative timer actuable to hold said first normally open switch in closed position during an off-peak period and to momentarily close said second normally open switch at a predetermined time during an off-peak period, electric connections between the coil of said electromagnetic switch, said second thermal switch and said

first and second normally open switches to cause closing movement of said electromagnetic switch and energization of said heater at the start of an off-peak period in case less than a predetermined fractional part of the water content of the tank is hot and to delay causing closing movement of said electromagnetic switch and energization of the heater for a fixed time interval after the start of an off-peak period in case more than said predetermined fractional part of the water content of the tank is hot.

10. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic heater control switch, a thermal heater control switch for deenergizing said heater when substantially all of the water in the tank is hot, a first normally open switch, a second thermal switch subject to tank water temperature, a second normally open switch, a continuously operative timer actuable to hold said first normally open switch in closed position during an off-peak period and to momentarily close said second normally open switch at a predetermined time during an off-peak period, electric connections between said second thermal switch, said first and second normally open switch and the coil of said electromagnetic switch to connect the coil, the second thermal switch and the first normally open switch in series circuit with each other and the second normally open switch in shunt circuit with said second thermal switch to preclude closing movement of said electromagnetic switch and energization of the heater at the start of an off-peak period in case said second thermal switch is subject to hot water and to cause closing movement of the electromagnetic

switch and energization of the heater at the time of momentary closure of said second normally open switch.

11. An off-peak water heating system for a hot water tank comprising an electric heater, an electromagnetic heater control switch, a thermal heater control switch for deenergizing said heater when substantially all of the water in the tank is hot, a first normally open switch, a second thermal switch subject to tank water temperature, a second normally open switch, a continuously operative timer actuable to hold said first normally open switch in closed position during an off-peak period and to momentarily close said second normally open switch at a predetermined time during an off-peak period, electric connections between said second thermal switch, said first and second normally open switch and the coil of said electromagnetic switch to connect the coil, the second thermal switch and the first normally open switch in series circuit with each other and the second normally open switch in shunt circuit with said second thermal switch to preclude closing movement of said electromagnetic switch and energization of the heater at the start of an off-peak period in case said second thermal switch is subject to hot water and to cause closing movement of the electromagnetic switch and energization of the heater at the time of momentary closure of said second normally open switch said energization of the heater continuing until substantially all of the water in the tank is hot irrespective of the operative position of said first normally open switch.

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