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WATER HEATER CONTROL SYSTEM

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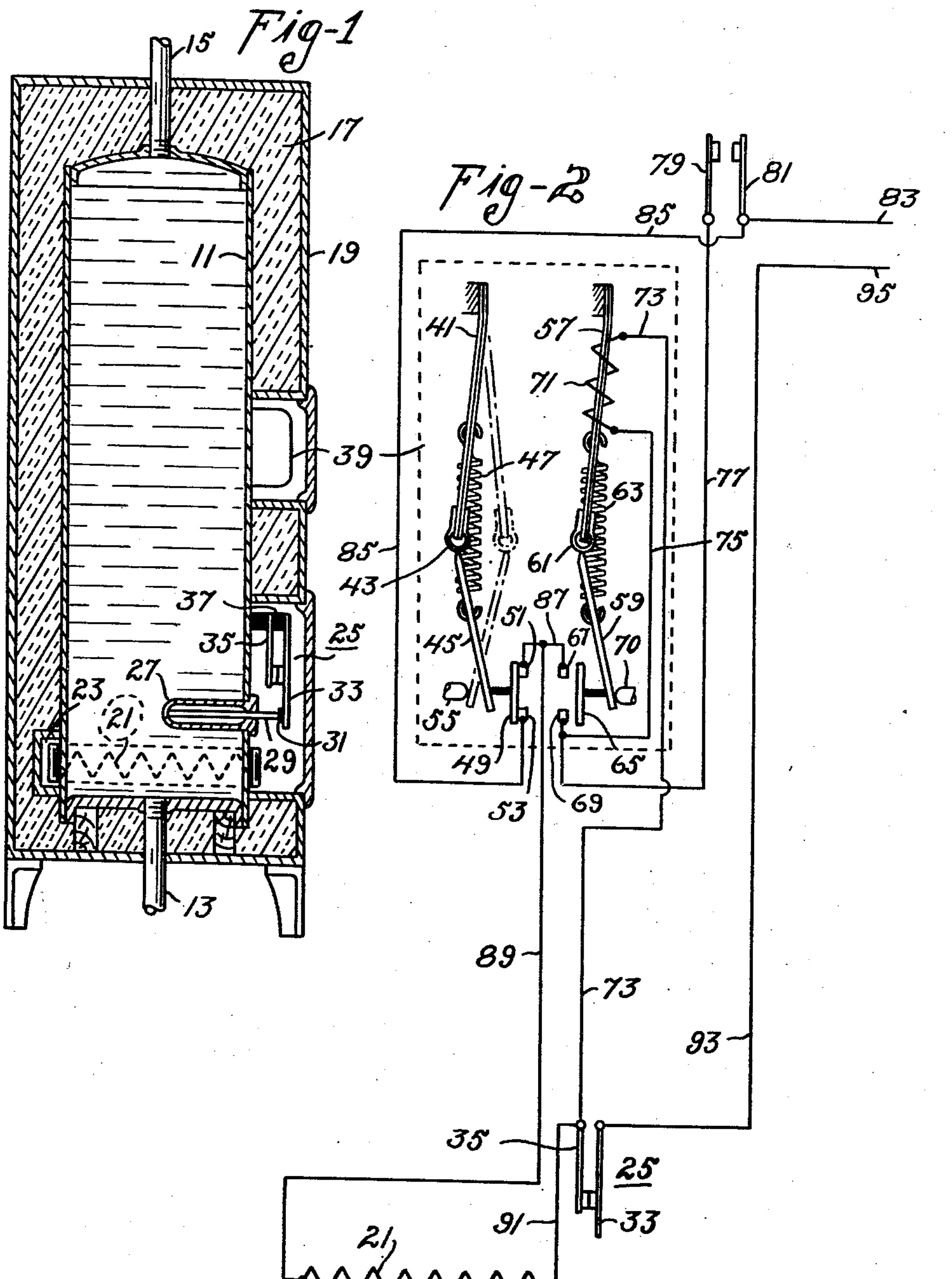

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WATER HEATER CONTROL SYSTEM

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6 Claims. (Cl. 219—39)

My invention relates to electric heating and particularly to systems for controlling the energization of the electric heater for a domestic hot water tank.

Among the objects of my invention are the following: to provide a control system for the electric heater of a domestic hot water storage tank that shall cause immediate energization of the heater in case a relatively large quantity of hot water is withdrawn from the tank and to cause deenergization of the heater when substantially one-half of the tank is full of hot water; to cause energization of the heater with a predetermined time delay period after closure of a time-controlled switch in case the tank contains only a relatively small amount of cold water and to cause deenergization of the heater when substantially all of the water in the tank is hot; to cause energization of the heater with a predetermined time delay period after closure of a time-controlled switch in case the tank contains only a relatively small amount of cold water at the time of closure of the time-controlled switch and to cause deenergization of the heater when the time-controlled switch is opened in case of withdrawal of additional quantities of hot water during the time when the time-controlled switch is in closed position.

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

In the drawing,

Figure 1 is a view in vertical section through a domestic hot water tank, having associated therewith the system embodying my invention, and,

Fig. 2 is a diagram of connections of the system embodying my invention.

Referring first of all to Fig. 1 of the drawing, I have there illustrated a usual domestic hot water tank **11** having a lower cold inlet pipe **13** and an upper hot water outlet pipe **15** and being surrounded by a layer of heat insulation **17**, which latter is held in proper operative position around the tank by an outer casing **19**.

I provide preferably, but not necessarily, a single electric heater **21**, which heater is located adjacent to the lower end portion of the tank **11** and which may be positioned in a tunnel member **23**. All of these details 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 generally by the numeral **25**, which comprises a tube **27** having a closed inner end and being secured in a fluid-tight manner into an opening in the tank **11** adjacent the lower end portion thereof. An expansion rod **29** is positioned within the tube **27** and is adapted to engage with and be disengaged from a lug **31** of electric-insulating material mounted on the free end of a switch arm **33** which is adapted to engage with and be disengaged from a switch arm **35**, the two contact arms being supported by blocks **37** of electric-insulating material. The arm **33** is resilient, while the arm **35** is substantially rigid. While I have shown a specific embodiment of a lower thermally-actuable switch, I do not desire to be limited thereto, since any other form, effective for the same purposes as is the switch shown, may be used in place thereof. The design, construction, and adjustment of the switch **25** is such that when the tube **27** is surrounded by cold water in the lower portion of the tank, the length of the expansion rod **29** will be such that the two contact arms **33** and **35** will be in engagement with each other. When the tube **27** is subject to hot water in the tank, the contact arm **33** will be moved out of engagement with contact arm **35**. When I refer to cold water, I mean water, the temperature of which is on the order of 60 to 70° F., and when I refer to hot water, I mean water the temperature of which is on the order of 150° F. or slightly above.

I provide also a thermal retarder, which I have designated by the numeral **39**, and the details of which are disclosed and claimed in my copending application, S. N. 537,941, filed May 29, 1944, and assigned to the same assignee as is the present application.

Only such description thereof will be given as appears necessary to a better understanding of the device, and reference may be had to the above identified application covering the same. The thermal retarder **39** is preferably located between the ends of the tank **11** and at substantially half of the vertical height thereof, although I do not desire to be limited to this particular point. It is to be understood that the thermal retarder heater control switch unit **39** is in good heat-conducting relation with the tank so that the thermal switches thereof will be subject to the temperature of the water in the tank at that particular point.

A first thermal switch includes a bimetal bar **41** having one of its ends fixed and having pivot plates **43** secured to the other free end thereof, which is of U-shape. These pivot plates are of substantially U-shape, having rounded intermediate portions, while the two end portions are suitably secured to the two end portions of the main bar 41. A second bimetal bar 45 is provided, having its sharpened end portions in pivotal operative engagement with the pivot plates 43. An over center spring 47 is provided, which is positioned in two central longitudinally-extending slots in the respective bars 41 and 45, the end portions of the spring 47 being connected with the respective bars 41 and 45 adjacent to the ends of the slots, so that the outer end of bar 45 will move with a snap action.

The second bimetal bar 45 has loosely insulatedly mounted thereon a contact bridging member 49 adapted to be engaged with and be disengaged from a pair of fixed contacts 51 and 53. The design, construction, and adjustment of the first thermal switch of the thermal retarder unit is such that the two bars 41 and 45 will be in the positions shown in full lines in Fig. 2 of the drawing so that the contact bridging member 49 will be in engagement with the contacts 51 and 53, when the bimetal bars are subject to cold water in the tank. When the bimetal bars 41 and 45 are subject to hot water in the tank, they will be in the positions shown by the broken lines in Fig. 2 of the drawing when the outer end of bimetal bar 45 will be in operative engagement with a stop member 55.

I provide a second thermal switch in the thermal retarder switch unit, comprising a first bimetal bar 57 and a second bimetal bar 59, the first bimetal bar 57 having one end fixed and having pivot plates 61 secured to the free end portions thereof, which pivot plates are adapted to be pivotally engaged by the sharp pointed ends of the second bimetal bar 59. The respective bimetal bars 57 and 59 have a central longitudinally-extending slot in their adjacent pivotally connected end portions, which slot is occupied by an over center spring 63, the ends of which are respectively connected to bimetal bars 57 and 59 adjacent to the ends of the slots, so that the free end of bar 59 moves with a snap action from one position to another.

The outer end of bimetal bar 59 has loosely insulatedly mounted thereon a contact bridging member 65 which is adapted to engage with and be disengaged from two fixed contact members 67 and 69. The design, construction, and adjustment of the second thermal switch comprising the bars 57 and 59 is such that the switch will be in open position, as is shown by the full lines in Fig. 2, when the switch is subject to cold water as well as to hot water in the tank and that it will be in closed position at an appreciably higher temperature, which, for illustrative purposes, may be taken to be on the order of 250° F. When the second switch is in open position, bimetal bar 59 will be in engagement with a stop member 70.

The bimetal bar 57 is provided with a low wattage heating coil 71, one terminal of which is connected by a conductor 73 to the rigid contact arm 35. The other terminal of coil 71 is connected by a conductor 75 with fixed contact 69, which contact is connected by a conductor 77 to one contact arm 79 of a time-controlled switch, which includes a second contact arm 81. The design and construction of the time-controlled switch, including the contact arms 79 and 81, may be any one of the standards now used in the art, and the operation of the time-controlled switch is such that the two contact arms 79 and 81 will be in electrical contact and engagement with each other during only the off-peak periods of a twenty-four hour day. Contact arm 81 is connected to a first supply circuit conductor 83 and is connected by a conductor 85 with fixed contact member 53. A conductor 87 connects the two fixed contacts 51 and 67, and a conductor 89 connects conductor 87 to one terminal of heater 21, the other terminal of which is connected by a conductor 91 to arm 35 of the lower thermally-actuable switch 25. The resilient contact arm 33 is connected by a conductor 93 to the other supply circuit conductor 95.

Let it now be assumed that a relatively large amount of hot water has been withdrawn from the tank during say on-peak periods, that is during either the early morning or the late afternoon or early evening hours. Let it be further assumed that the quantity thus withdrawn was sufficient to cause entry of enough cold water into the tank to subject the thermal retarder switch 39 to cold water. When this occurs, the first thermal switch, comprising bimetal bars 41 and 45, will be moved with a snap action from open position to closed position, substantially as shown by the full lines in Fig. 2. This will close an energizing circuit through heater 21, traceable as follows: from the first supply circuit conductor 83 through conductor 85, to and through the engaged contacts 53, 51, and contact bridging member 49, through a part of conductor 87, and through conductor 89 to heater 21, through conductor 91, through the also closed switch 25, and from there through conductor 93 to the second supply circuit conductor 95. It is evident, of course, that cold water entering the tank, to replace hot water withdrawn therefrom through the upper hot water outlet pipe 15, will first fill the lower portions of the tank 11 so that in case enough cold water enters the tank to subject the thermal retarder unit to cold water, the lower thermally-actuable switch 25 will also be subject to cold water.

This energization of the heater 21 will therefore cause heating up of the cold water in the tank, which will continue until such time when the first thermal switch, comprising bimetal bars 51 and 45, is again subject to hot water, when the contact bridging member 49 will be moved out of engagement with fixed contacts 51 and 53 with a snap action and thereby deenergize the heater 21.

It will be evident that the operation of the control system thus far described is to ensure that there will be not less than substantially one-half tankful of hot water available for use in the home at all times.

Let it now be assumed that during daylight hours, only enough hot water is withdrawn from the tank to subject the lower thermally-actuable switch 25 to cold water, with resultant closure of the lower switch 25. This will have no effect upon the heater 21, nor upon the heating coil 71, until the beginning of an off-peak period when contact arms 79 and 81 will be moved into engagement with each other, whereby an energizing circuit is closed through heating coil 71, traceable as follows: from the first supply circuit conductor 83, through the engaged contact arms 81 and 79, conductors 77 and 75, through heating coil 71, conductor 73, through engaged contact arms 35 and 33, and from there through conductor 93 to the second supply circuit conductor 95. The amount of energy translated into heat in heating coil 71 is on the order of only a relatively few watts, so that the length of time necessary to cause heating of the bimetal bar 57 to a temperature on the order of 250° F. will be say from four to six hours. Let it now be assumed that the beginning of an off-peak period during the night hours is say 10 p. m., so that either at 2 a. m. or at 4 a. m. the temperature of the bimetal bar 57 will have been raised to a value on the order of 250° F., with consequent sudden closure of the second thermal switch, comprising the bimetal bars 57 and 59. This will cause energization of heater 21 through a circuit traceable as follows: from the first supply circuit conductor 83 through the engaged contact arms 81 and 79, through conductor 77, through the engaged contacts 69 and 67 and contact bridging member 65, through a part of conductor 87, through conductor 89, through heater 21, through conductor 91, through the engaged contact arms 35 and 33, and from there through the conductor 93 to the second supply circuit conductor 95. This energization of the heater 21 will cause temperature rise of the cold water at the lower end portion of the tank, and it may be assumed that energization began at 2 a. m., thus leaving four hours of continued closure of the time-controlled switch, until 6 a. m., when the switch will probably be opened. This will be sufficient time, under ordinary operating conditions, to cause all of the cold water in the tank to be heated before opening of the time-controlled switch. Should there be demands for hot water during the late night hours, say around four or five a. m., energization of heater 21 will continue until the opening of the time-controlled switch, which will cause deenergization of the heater 21, irrespective of whether all of the water in the tank is hot or not.

In case, however, all of the water in the tank is hot before opening of the time-controlled switch at the end of the night off-peak period, the heater 21 will be deenergized by opening of the thermally-actuable switch 25.

The system embodying my invention is thus effective to ensure that at least one-half tankful of hot water will be available for use at any time during a twenty-four hour day and that substantially all of the water in the tank will be hot at the beginning of daylight hours.

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

I claim as my invention:

1. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to be mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, means for heating said second thermal switch to said higher temperature and electric connections between said switches and said heater to cause immediate energization of said heater, irrespective of the position of said time-controlled switch in case said thermal retarder is subject to cold water in the tank, said energization continuing until said thermal retarder is subject to hot water.

2. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, a heating coil for said second thermal switch controlled jointly by said lower thermally-actuable switch and said time-controlled switch, and electric connections between said heater and said switches to cause immediate energization of said heater in case the first thermal switch of said thermal retarder is subject to cold water in the tank and deenergization of said heater as soon as said first switch is subject to hot water in the tank.

3. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to be mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, a heating coil for said second thermal switch controlled jointly by said lower thermally-actuable switch and said time-controlled switch, and electric connections between said heater and said switches to cause immediate energization of said heater in case the first thermal switch of said thermal retarder is subject to cold water in the tank and deenergization of said heater as soon as said first switch is subject to hot water in the tank, and to cause energization of said heater after a predetermined time delay period after closing of said time-controlled switch in case said lower thermal switch only is subject to cold water at that time,

said energization being ended by said lower thermally-actuable switch when subject to hot water in the tank in case such condition occurs before opening of the time-controlled switch.

4. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to be mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, a heating coil for said second thermal switch controlled jointly by said lower thermally-actuable switch and said time-controlled switch, and electric connections between said heater and said switches to cause immediate energization of said heater in case the first thermal switch of said thermal retarder is subject to cold water in the tank and deenergization of said heater as soon as said first switch is subject to hot water in the tank, and to cause energization of said heater after a predetermined time delay period after closing of said time-controlled switch in case said lower thermal switch only is subject to cold water at that time, said energization being ended by said time-controlled switch in case less than substantially all of the water in the tank is hot at the end of an off-peak period.

5. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to be mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, a heating coil for said second thermal switch controlled jointly by said lower thermally-actuable switch and said time-controlled switch and electric connections between said heater and said switches to cause immediate energization of said heater through said lower thermally-actuable switch and the first thermal switch of said thermal retarder unit in case said first thermal switch is subject to cold water, said first thermal switch causing deenergization of said heater when subject to hot water in the tank.

6. A control system for an electric heater of a domestic hot water tank subject to withdrawals of hot water during a twenty-four hour day, comprising a lower thermally-actuable heater control switch located in heat-receiving relation on the tank at the lower end portion thereof and adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a time-controlled switch adapted to be in closed position during off-peak periods only, a thermal retarder heater control switch unit adapted to be mounted in heat-receiving relation on a tank intermediate the ends thereof and including a first thermal switch adapted to be in closed position when subject to cold water in the tank and to be in open position when subject to hot water in the tank, a second thermal switch adapted to be in open position when subject to hot water in the tank and to be in closed position when heated to an appreciably higher temperature, a heating coil for said second thermal switch controlled jointly by said lower thermally-actuable switch and said time-controlled switch and electric connections between said heater and said switches to cause energization of said heater after a predetermined time delay period after closure of said time-controlled switch, through said lower thermally-actuable switch, said time-controlled switch and said second switch of the thermal retarder unit in case said lower thermally-actuable switch only is subject to cold water, the energization of said heater being terminated by said lower thermally-actuable switch in case substantially all of the water in the tank is hot before opening of the time-controlled switch.

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