

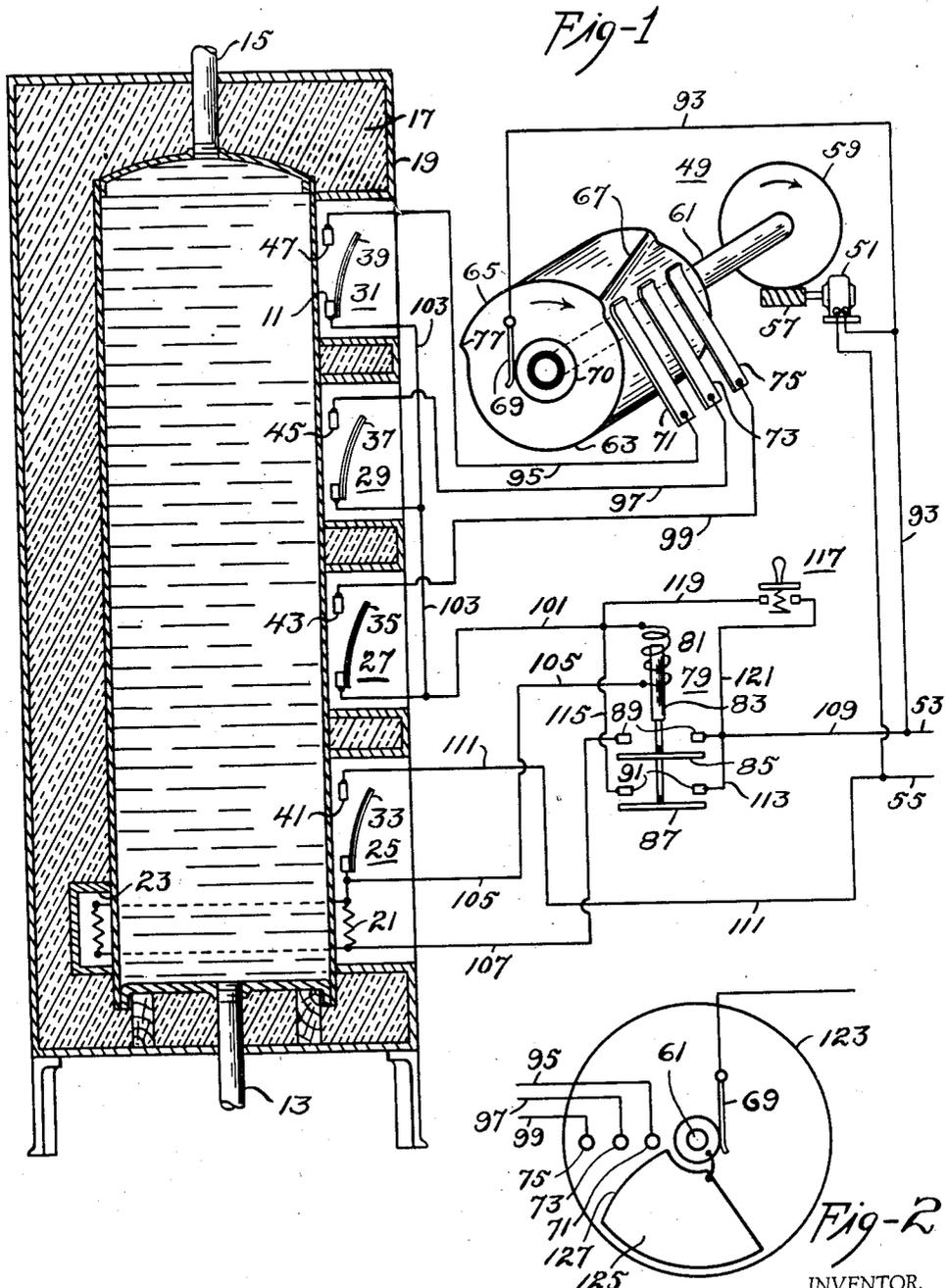
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OFF-PEAK WATER HEATING SYSTEM

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## OFF-PEAK WATER HEATING SYSTEM

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My invention relates to heating systems and particularly to electric off-peak water heating systems.

An object of my invention is to provide a relatively simple off-peak water heating system particularly applicable to domestic hot water tanks whereby the energization of the heater is delayed for predetermined lengths of time in case the tank contains predetermined different amounts of hot water at the start of an off-peak period.

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 hereinafter in the course of such description or set forth in the appended claims.

In the single sheet of drawings:

Figure 1 is a view, in vertical section, through an ordinary hot water tank having associated therewith a control system for the electric heater thereof, embodying my invention, and,

Fig. 2 is a view of a modified form of contact means embodying my invention.

I have illustrated a domestic hot water tank 11 which may have provided thereon a cold water inlet pipe 13 and a hot water outlet pipe 15. The tank may be surrounded by a mass of heat insulating material 17 which may be properly supported and protected by an outer casing 19.

I provide an electric heater 21 which is shown schematically or generally only and if this heater is to be mounted on the tank against the outer surface thereof, it may be positioned in a tunnel 23, all in a manner well known in the art.

I provide a plurality of thermal switches responsive to the temperature of the water at selected different points or heights of the tank and I have shown four such switches numbered 25, 27, 29 and 31. These thermal switches are shown generally only as including bimetal bars 33, 35, 37 and 39, each having one end thereof fixedly mounted on a suitable contact member so applied to or mounted on the tank as to receive heat therefrom. The respective thermal switches include fixed contact members 41, 43, 45 and 47 adapted to be engaged by and disengaged from the respective flexible bimetal bars.

I provide a continuously operative timing means 49 which is shown as including an electric motor 51 which is permanently connected to suitable supply circuit conductors 53 and 55. I mount a worm wheel 57 on the shaft which is adapted to mesh with and drive a worm gear 59. I desire it to be understood that this showing of a continuously operative timing means is representative only and it is to be understood that

changes may be made in the mechanical details of the drive within the province of my invention which contemplates causing rotation of a certain element, namely a contact member, once in twenty-four hours.

The worm gear 59 may be mounted on a shaft 61 which may have mounted thereon a circular contact member 63 insulated therefrom by suitable means. The member 63 is here shown as being a cylinder having a uniform outer radius over the major portion, substantially two-thirds of its periphery, while a second portion 65 is of larger outer radius and has a leading edge 67 which extends angularly relatively to the axis of member 63. While I have not shown any supporting bearings for shaft 61 it is to be understood that such bearings will be supplied.

I provide a contact arm or brush 69 which is shown as being adapted to engage a portion 70 of member 63 having a uniform outer radius. I also provide three additional brushes or contact arms 71, 73 and 75 which are suitably supported in side-by-side or in longitudinally spaced positions to be adapted to engage, in sequence, the leading edge 67 of the portion 65. It is to be understood that the trailing edge 77 of portion 65 extends substantially axially of the shaft 61.

The heater 21 is controlled by an electromagnetic switch or contactor 79 including a coil 81 and a magnetizable core member 83. A main contact bridging member 85 and an auxiliary contact bridging member 87 are suitably connected with core 83 to move therewith. The bridging member 85 is adapted to engage with and be disengaged from fixed contact members 89 while the auxiliary bridging member 87 is adapted to engage with and be disengaged from fixed contact members 91.

Supply circuit conductor 53 is connected by a conductor 93 with brush 69. Brush 71 is connected by a conductor 95 with fixed contact member 47 of the uppermost thermal switch 31 and I wish to here point out that with clockwise rotation of member 63 brush 71 will be the first of the three brushes to engage the contact surface 65. I wish to point out further that while I have shown member 63 as being made of electric conducting material, I can make the portion other than element 65 of non-conducting material and merely mount thereon an electric conducting surface 65 of the hereinbefore described type.

Brush 73 is connected by a conductor 97 with fixed contact member 45 of the second uppermost thermal switch 29. Brush 75 is connected by a

conductor 99 with fixed contact member 43 of thermal switch 27. One terminal of coil 81 is connected by a conductor 101 with the fixed contact supporting bimetal bar 35 of thermal switch 27 and a conductor 103 connects conductor 101 with the fixed supports of bimetal bars 37 and 39. The other terminal of coil 81 is connected by a conductor 105 with one terminal of coil 21 and with the fixed support of bimetal bar 33 of the lowermost thermal switch 25. The other terminal of heater 21 is connected by a conductor 107 with one of the fixed contact members 89 while the other fixed contact member 89 is connected by a conductor 109 with supply circuit conductor 53. Fixed contact member 41 of the lowermost thermal switch 25 is connected by a conductor 111 with the other supply circuit conductor 55.

For illustrative purposes it may be pointed out that the maximum peripheral extent of the contact surface 65 is equal substantially to that of the length of an off-peak period and I have shown this as being equal to substantially eight hours. The position in which contact surface 65 is shown is that which it would occupy just a short time before 10 P. M. on the assumption that the utility supplying current to energize my improved system would consider that an off-peak period extended from substantially 10 P. M. to 6 A. M.

As soon as brush 71 engages the leading edge 67 of contact member 65 and, assuming that the bimetal bar 39 is in engagement with fixed contact 47, an energizing circuit through coil 81 will be established substantially as follows: From supply circuit conductor 53 through conductor 93 and brush 69 to the contact member 63 and from there through the brush 71 and conductor 95 and through the engaged parts of the uppermost thermal switch 31, through conductors 103 and 101, through coil 81, through conductor 105 and the closed lowermost thermal switch 25 and from there through conductor 111 to the other supply circuit conductor 55. It may be here pointed out that the engagement of flexible bimetal bar 39 with the fixed contact 47 indicates that the uppermost thermal switch 31 is subject to the temperature of relatively cold water and it is, therefore, desired to effect closure of the contactor 79 substantially at the start of an off-peak period. It is to be further noted that when the uppermost thermal switch 31 is closed because of being subjected to cold water, all of the thermal switches mounted on the tank will also be closed.

Energization of the coil 81 through the circuit above described will cause energization of heater 21 through a circuit substantially as follows: From supply circuit conductor 53 through conductor 109, through engaged contact members 89 and 85, conductor 107 to and through heater 21 and from there through the closed lowermost thermal switch 25 and from there through conductor 111 to the other supply circuit conductor 55. This operation will therefore start heating of the water in the tank at substantially the start of an off-peak period.

I provide also a holding circuit for the coil 81 which may be traced as follows: From supply circuit conductor 53 through conductors 109 and 113 to one of the auxiliary fixed contact members 91, from there through the contact bridging member 87 and the other contact 91, through a conductor 115 to one of the terminals of coil 81, through coil 81 and conductor 105 to and through

the closed lowermost thermal switch 25 and from there through conductor 111 to the other supply circuit conductor 55. It will be noted that this holding circuit is entirely independent of brush 71 and the contact surface 65.

Let it now be assumed that the uppermost thermal switch 31 was in the position shown in Fig. 1 of the drawing at the start of an off-peak period, that is, at least the uppermost part of the tank was filled with hot water but that the second thermal switch 29 was subject to cold water when it would be in closed position instead of the position shown in Fig. 1 of the drawing. The same energizing circuit through coil 81 of the thermally actuatable switch 79 will be established at a later time after the start of an off-peak period by engagement of second brush 73 with the contact surface 65 and this energizing circuit will include conductor 97 and closed switch 29 instead of the conductor 95 and closed switch 31.

Let it be assumed that the tank contains a still greater amount of hot water at the start of an off-peak period so that the two uppermost thermal switches 31 and 29 are subject to hot water but that thermal switch 27 is subject to cold water. In this case energization of the heater 21 will be delayed for a still longer time after the start of an off-peak period or until brush 75 engages contact surface 65 when a similar energizing circuit through coil 81 will be established, this circuit including conductor 99 and the closed switch 27 instead of the similar conductors and switches hereinbefore mentioned as constituting parts of different energizing circuits for coil 81.

Let it be assumed, for purposes of illustration, that the tank contained a relatively large amount of hot water at the start of an off-peak period and that substantially all of the water in the tank was heated or became hot say an appreciable time before the end of an off-peak period at which time all of the brushes 71, 73 and 75 were still in engagement with the contact surface 65. It is therefore evident that all of the thermal switches would be in their open position with consequent deenergization of heater 21 which condition insofar as the contactor 79 and the thermal switches are concerned, is that shown in Fig. 1 of the drawing.

Let it now be assumed that such an amount of hot water is withdrawn, shortly before the end of an off-peak period, as will subject the two lowermost thermal switches 25 and 27 to cold water with attendant closing of these switches. The contactor 79 will have its coil 81 reenergized through the action of the second lowermost thermal switch 27 and the brush 75, which latter is still in engagement with contact surface 65 because the end of an off-peak period has not yet arrived. Reenergization of the heater 21 will therefore be effected and since the holding circuit for the coil 81 is independent of the brush or brushes engaging a continuously movable contact surface, energization of the heater 21 will continue beyond the end of an off-peak period and the heater 21 will be deenergized only when substantially all of the water in the tank is hot when bimetal bar 33 will move to the position shown in Fig. 1 to interrupt the holding circuit and permit the contactor to move to the position shown in the full lines in Fig. 1 of the drawing. My system therefore provides main heater controlling switching means effective to continue or prolong the energization of the heater beyond the end of an off-peak period should the conditions hereinbefore set forth occur.

It may happen that the demand for hot water on any one day is greater than ordinarily occurring and the user might wish to effect energization of the heater 21 and for this purpose I provide a small push button switch 117 normally open but adapted to be moved into closed position by the user. One terminal of switch 117 is connected by a conductor 119 to conductor 101 and therefore to one terminal of coil 81, while the other terminal of switch 117 is connected by a conductor 121 to conductor 109. An inspection of the circuit provided by the closed switch 117 will show that the coil 81 is energized through a circuit including supply circuit conductor 53, conductors 109 and 121, switch 117, conductor 119, coil 81, conductor 105, closed switch 25 and from there through conductor 111 to the other supply circuit conductor 55. This momentary closure of switch 117 will therefore effect energization of the heater 21 irrespective of the operating position of the timing means hereinbefore described and it is further evident that this energization of heater 21 will continue until the tank is again filled with hot water.

Referring now to Fig. 2 of the drawing, I have there shown a modified form of continuously movable contact surface and only those parts differing from those shown in Fig. 1 are here illustrated. I provide a flat relatively thin disk 123 of electric insulating material having mounted thereon an electric conducting contact surface 125 which may be electrically connected to shaft 61 on which disk 123 is suitably mounted. I provide three brushes which, for convenience, are given numbers 71, 73 and 75 as in Fig. 1 of the drawing, and which are so supported relatively to the leading edge 127 of contact surface 125 that brush 71 will engage the leading edge 127 of member 125 at substantially the start of an off-peak period. Brush 73 will engage member 125 later and brush 75 will engage contact surface 125 at a still later time thus providing two fixed delays for energization of coil 21, the operation of my system including the parts shown in Fig. 2 of the drawing being therefore substantially the same as was hereinbefore set forth for the contact surface 65 in Fig. 1 of the drawing.

Various modifications may be made in the system embodying my invention as herein shown and described and all such modifications clearly coming within the scope of the appended claims are to be considered as being covered thereby.

I claim as my invention:

1. In an off-peak water heating system for a tank having a single electric heater, an electromagnetic switch for said heater, a continuously operative timer, an electric conducting plate adapted to be moved by said timer, a plurality of fixed contact brushes adapted to be engaged by said plate, a plurality of thermal switches located at different heights on the tank, electric connections between said thermal switches, said contact brushes and said electromagnetic switch to cause energization of the electromagnetic switch and of the electric heater a period of time after the start of an off-peak period, which period increases with the amount of hot water in the tank.

2. In an off-peak water heating system for a tank having a single electric heater near the lower end of the tank, an electromagnetic switch for said heater, a continuously operative timer, an electric conducting plate having an angularly

extending leading edge moved continuously by said timer, a plurality of fixed contact brushes adapted to be engaged by said plate in predetermined time sequence, a plurality of thermal switches located at different heights on the tank, electric connections between said thermal switches, said contact brushes and said electromagnetic switch to cause different delay times after the start of an off-peak period in the energization of the electromagnetic switch and of the heater in accordance with the position of the thermal switch on the tank which is subject to cold water.

3. In an off-peak water heating system for a tank having a single electric heater near the lower end of the tank, an electromagnetic switch for said heater, a continuously operative timer, an electric conducting plate having an angularly extending leading edge moved continuously by said timer, a plurality of fixed contact brushes adapted to be engaged by said plate in predetermined time sequence, a plurality of thermal switches located at different heights on the tank, electric connections between said thermal switches, said contact brushes and said electromagnetic switch to cause different delay times after the start of an off-peak period in the energization of the electromagnetic switch and of the heater in accordance with the position of the thermal switch on the tank which is subject to cold water and a thermally actuatable heater control switch to cause deenergization of the heater when substantially all of the water in the tank is hot.

4. In an off-peak water heating system for a tank having an electric heater, an electromagnetic switch for said heater, a continuously operative timer, an electric conducting plate adapted to be moved by said timer, a plurality of fixed contact brushes adapted to be engaged by said plate, a plurality of thermal switches located at different heights on the tank, electric connections between said thermal switches, said contact brushes and said electromagnetic switch to cause different delay times after the start of an off-peak period in the energization of the electromagnetic switch and of the heater in accordance with the position of the thermal switch on the tank which is subject to cold water and a thermally actuatable heater control switch to cause deenergization of the heater when substantially all of the water in the tank is hot and to cause reenergization of said heater in case of withdrawal of hot water before the end of an off-peak period sufficient to subject at least the second-lowest thermal switch to cold water.

5. A system as set forth in claim 4 and including a normally open switch movable into momentarily closed position to cause energization of said electromagnetic switch and of said heater at any desired time during an on-peak period in case less than all of the water in the tank is hot, said energization of the heater continuing until substantially all of the water in the tank is hot.

6. A system as set forth in claim 3 and including a normally open switch manually movable into momentarily closed position to cause energization of said electromagnetic switch and of said heater at any time in case said thermally actuatable heater control switch is in circuit closing position by being subject to cold water.

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