United States Patent

Lee

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[54] HEATING-ELEMENT PROTECTOR FOR ELECTRIC WATER-HEATER

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[52] **U.S. Cl.** .....**219/333,** 137/202, 200/83 R, 219/322, 219/332, 219/496

[51] **Int. Cl.** **H05b 1/02**

[58] **Field of Search** .....137/202; 200/81 R, 83 R; 219/309, 322–324, 332, 333, 496

[56] **References Cited**

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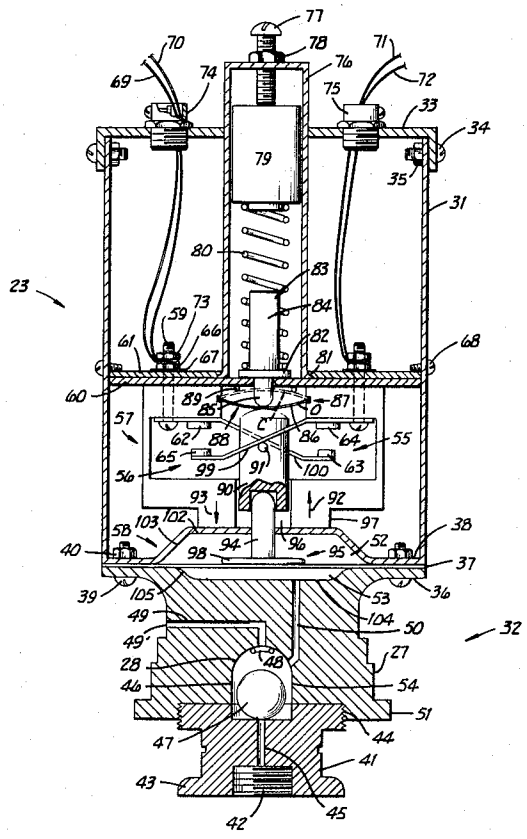
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[57] **ABSTRACT**

A device for preventing electrical energy flow to a water heating element when an insufficient amount of water is in contact with the element for absorbing the heat generated. The device or element protector is coupled to an exit pipe which extends into the heating tank immediately above the heating element. Normally open contact switches within the protector allow electrical energy flow to the element only when water covers the element and has entered the protector causing a diaphragm and a movable structure to force the switches closed. A helical spring and snap disc are employed to allow the switches to close and open at different pressure points. Means are provided to adjust the spring for different operating pressures. A float and chamber within the protector prevent switch activation when water does not cover the heating element.

8 Claims, 4 Drawing Figures



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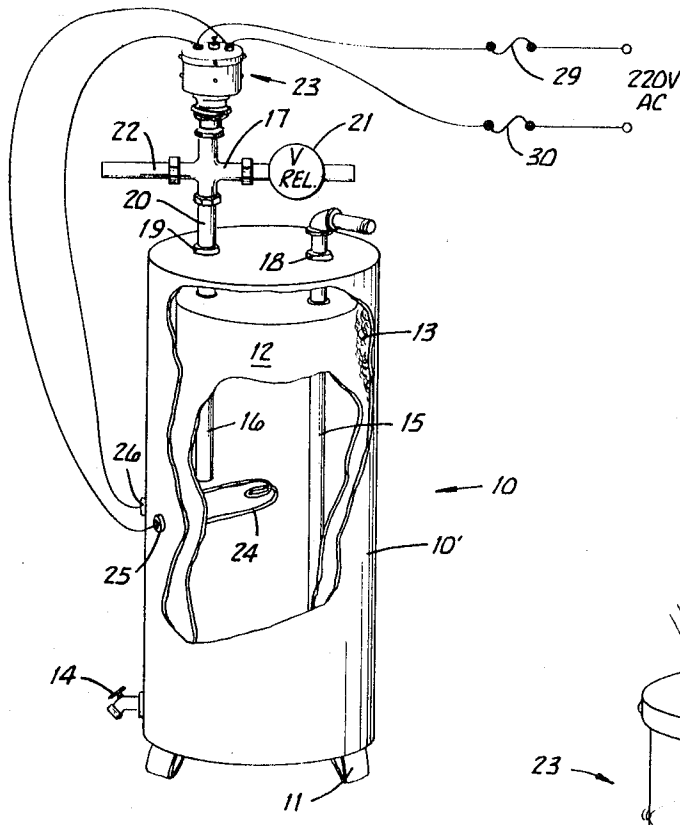


Fig.1.

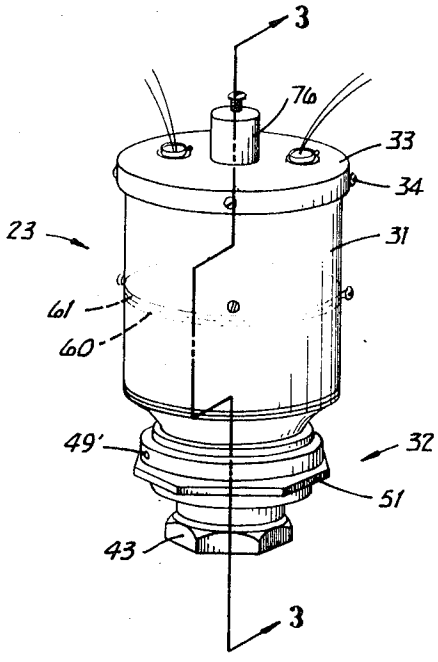


Fig.2.

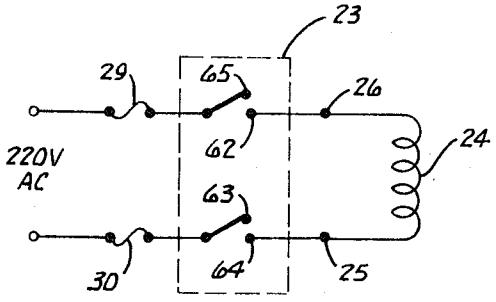


Fig.4.

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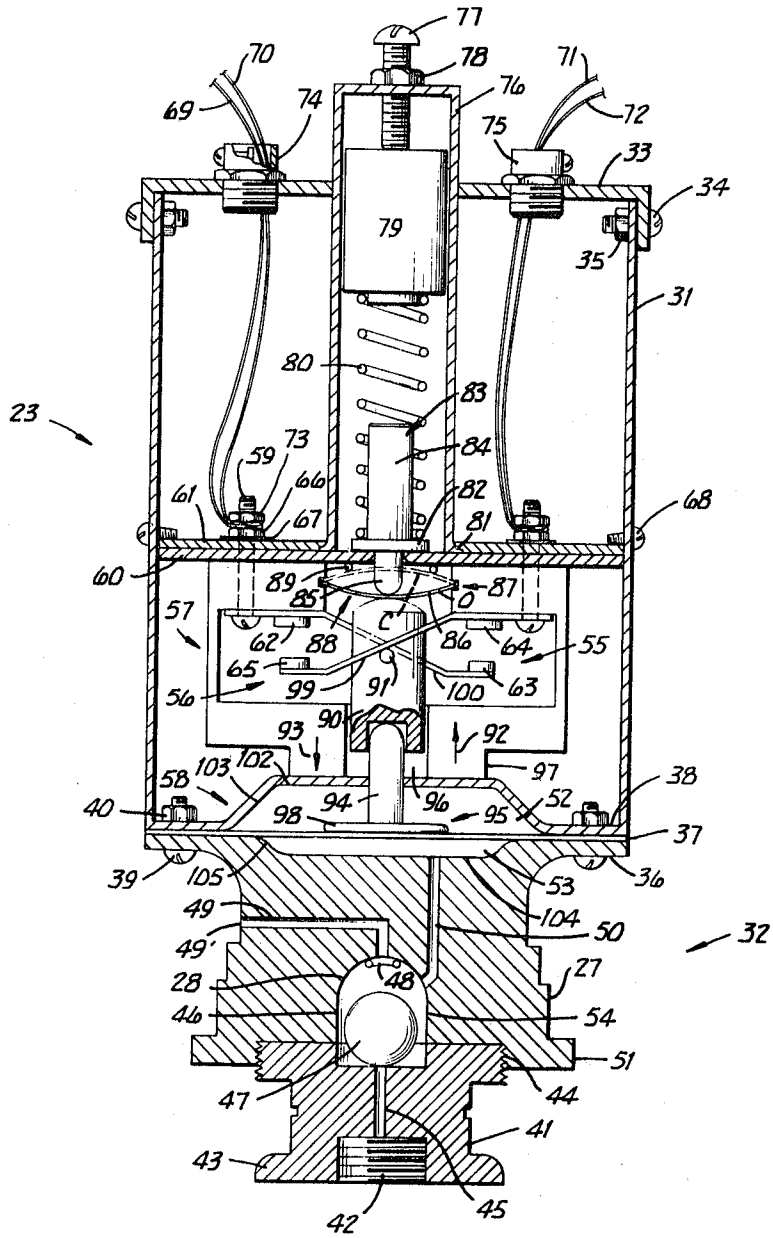


Fig. 3.

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HEATING-ELEMENT PROTECTOR FOR ELECTRIC WATER-HEATER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an element protector.

2. Description of the Prior Art

In the typical electric water heater, a heating element is immersed in the tank in order to heat the water to a predetermined temperature. Electrical energy is supplied to the element, with the internal resistance of the element resulting in the production of heat. The element is particularly susceptible to damage in the event that an insufficient amount of water is in contact with the element to absorb the heat generated. In many cases, this will result in complete destruction of the element.

An electric water heater is installed in a new building generally before the building is complete and before the main electricity and main water are provided. Nevertheless, the installer will connect the heater to the electric power lines and the input water pipe. Subsequent to this installation, the main electricity may be turned on prior to the main water supply. Thus, the heating element will be destroyed since water heater tank does not contain water.

It is therefore desirable to prevent electrical energy flow to the element when an insufficient amount of water is in contact with the element. On the other hand, the element protector should not interrupt the flow of the electrical energy as a result of variations in the water pressure when there is sufficient water to absorb the heat from the element.

SUMMARY OF THE INVENTION

The present invention involves an element protector. One use of the invention is for preventing electric energy flow to a water heating element when an insufficient amount of water is in contact with the element for absorbing the heat generated. The protector is coupled to an exit pipe which extends into the heating tank immediately above the heating element. Normally open contact switches within the protector allow electrical energy to flow to the element only when water covers the element and has entered the protector causing a diaphragm and a movable structure to force the switches closed. A float and chamber within the protector prevent activation of the switches when water does not cover the element. A helical spring and snap disc are employed to allow the switches to close and open at different pressure points. An adjustment screw is provided for changing the pressure points at which the switches open and close.

It is an object of the present invention to provide a device for preventing the flow of electrical energy to a heating element within a water heater tank when insufficient water exists within the tank to absorb the heat generated by the element.

It is another object of the present invention to provide a reliable element protector which may be easily attached to a water heater.

Yet another object of the present invention is to provide an element protector which will not interrupt the electrical energy flow as a result of pressure variations when sufficient water exists within the tank to absorb the heat generated by the element.

Related objects and advantages will be evident from the following description and drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side perspective view of an electric water heater having the element protector of the present invention affixed thereto and showing a cut-away section of the inner tank.

FIG. 2 is an enlarged perspective view of the element protector shown in FIG. 1.

FIG. 3 is a sectional view of the element protector taken along the line 3—3 and viewed in the direction of the arrows in FIG. 2.

FIG. 4 is an electrical schematic representation of the element protector connected between the source of electrical energy and the heater element.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to FIG. 1, there is illustrated a conventional electric water heater **10** having an outer tank **10'** supported by legs **11**. An inner tank **12** is located within outer tank **10'** being surrounded on all sides by insulating material **13** for reducing or preventing heat transfer between tank **12** and the outer environment.

Tank **12** has an outlet near its bottom connected to faucet **14** which is mounted to outer tank **10'** for draining purposes. Cold water from a main water supply, not shown, enters tank **12** through inlet pipe **15** secured and sealed to outer tank **10'** by housing **18**. The heated water exits tank **12** through outlet pipe **16** secured and sealed to outer tank **10'** by housing **19**. Of course, pipes **15** and **16** pass through openings in the top wall of tank **12** and are sealed thereto. Pipe **20** is threaded into housing **19** and is threaded on its opposite end to a four-way coupling **17**. A conventional pressure-temperature relief valve **21** is threaded on one of the outlets of coupling **17** for safety purposes while pipe **22** is threaded on one of the other outlets of coupling **17** to route the hot water to various user locations. The fourth outlet of coupling **17** is threaded into threads **42**, shown in FIG. **3**, of water heater element protector **23**.

The water within tank **12** is heated to the desired temperature by a heater element **24** having terminals **25** and **26** mounted to the outside surface of tank **10'** for receiving electrical energy. Element **24** is located within tank **12** and is immersed in the water. 220 volt AC is used to power the heater element, shown in FIG. **2**, and is routed through fuses **29** and **30**, through element protector **23** and finally to element terminals **25** and **26**. Of course, electrical connectors may be used at strategic locations to facilitate any wiring connections required between the terminals, element protector and the power source.

FIG. **2** is an enlarged perspective view of the element protector **23** shown in FIG. **1**. A sectional view of the element protector taken along the lines **3—3** in the direction of the arrows is shown in FIG. **3**. Element protector **23** is a combination electrical and hydraulic assembly. The electrical mechanism is housed in container **31** which has a lid **33** fastened to its top by screws **34** and nuts **35**. Captive nuts **35** may be secured around the top inside surface of the container wall in order to allow the fastening of screws **34** from the outside of the container. Hydraulic assembly **32** is fastened by its circular flange **36** to flat portion **38** extending around the bottom of container **31** by screws **39** and nuts **40**. Diaphragm **37**, having an outside diameter approximately equal to the outside diameter of container **31** and assembly **32** at its circular flange **36**, is fastened between the container and hydraulic assembly. Holes are provided in diaphragm **37** to allow screws **39** to pass through. Screws **39** are tightened sufficiently so as to insure a water tight seal between diaphragm **37** and flange **36**. This seal must extend around the top periphery of chamber **53** thereby preventing escape of pressure within the chamber to be described later in this description.

A water floatable sphere **47** is located in float chamber **46** which is formed within hydraulic assembly **32** by supporting member **27** and mounting **41**. Hexagonal shaped flanges **51** and **43** are formed respectively on member **27** and mounting **41** in order to provide wrench grasping surfaces for tightening the threads of mounting **41** to the threads of member **27** as shown at point **44**. A water sealant may be placed in these threads to prevent water from leaking out through the threads from float chamber **46**. A passageway or tube **45** connects float chamber **46** with coupling **17**. Element protector **23** is threaded onto one of the outlets of coupling **17** by threads **42** provided in mounting **41**. The hexagonal shaped flange **43** may be grasped with a wrench in order to tighten the element protector to the coupling.

The top portion 28 of float chamber 46 is dome-shaped having an air tube 49 connecting the top portion of chamber 46 with the outside environment through opening 49'. Tube 50 connects float chamber 46 with chamber 53 and enters the dome-shaped portion 28 of float chamber 46 at a point slightly above the vertical side wall 54. The functions of tubes 45, 49 and 50 will be explained in the operation section of this specification. An O-ring 48 is fastened by adhesives or other means around the opening of tube 49 into top portion 28 and provides a sealing seat for sphere 47 when the sphere floats to the top of chamber 46.

Container 31 houses switch box 57 which has two normally open electrical contact switches 55 and 56. Contacts 62 and 65 are provided on switch 56 and contacts 63 and 64 are provided on switch 55. Each contact is connected to a separate terminal screw 59 in order that a separate input and output terminal will be provided for each switch. Box 57 rests on upraised portion 58 of container 31 and is fastened by the four terminal screws 59 to discs 60 and 61. Terminal screws 59 are securely fastened to box 57 in order to prevent rotation of the screws when nuts 66 are tightened thereon. Lock washers 67 may be placed between nuts 66 and the top of disc 61 to better secure box 57 to the discs. Discs 60 and 61 should be made from a material, such as plastic, which will not conduct electrical energy since screws 59 are used simultaneously as fastening devices and as electrical terminals. Screws 68 are threaded through the wall of container 31 immediately above disc 61 and abuttingly rest on the top surface of disc 61 thereby preventing box 57 from moving upwardly. Insulated wires 69, 70, 71 and 72 are respectively connected to the four terminal screws 59 and are secured thereon between nuts 66 and 73. Wires 69 through 72 are then routed through lid 33 connecting heater element 24 with the source of electrical energy as previously described. An electrical schematic representation of the element protector is shown in FIG. 4 and will be described in the operation section of this specification. Two wire holders 74 and 75 are threaded in the top wall of lid 33 and respectively secure wires 69, 70, and 71, 72.

As may be seen from FIG. 2, tube 76 extends through lid 33 down to discs 61 and 60. A cutaway view of tube 76 is shown in FIG. 3. Tube 76 extends through disc 61 and rests on the top surface of disc 60. Flange 81 is formed around the bottom edge of tube 76 completely surrounding the tube and fits into a complimentary recess formed in the bottom surface of disc 61. Helical spring 80 is housed in tube 76 abuttingly engaging the bottom of spacer 79 and the top of flange 82 of movable element 83. An adjustment screw 77 is threaded through the top wall of tube 76 having a blunt end for forcing spacer 79 against spring 80. Screw 77 may be turned to increase or decrease the space within which spring 80 is located and thereby changing the force which spring 80 applies to flange 82. Nut 78 is positioned between the head of screw 77 and the top wall of tube 76 for locking the adjustment screw. The nut should be tightened against the top wall of tube 76 in order to lock screw 77 in place. Movable element 83 has a shank 84 for fitting within spring 80 insuring proper seating of the spring on flange 82. In addition, element 83 has a finger 85 which extends through an opening in disc 60 abutting against a concave or convex snap disc 86. The snap disc is made from tempered steel plate and is secured to switch box 57 by means of a wedge-shaped groove 87 extending around the opening 88 in box 57. The outer edge of snap disc 86 is located within groove 87 allowing the disc to snap from one position to another when force is applied. The disc has two positions which are the open position, illustrated and shown by line O, and the closed position, illustrated and shown by dashed line C. Metal ring 89 is fastened by adhesives or other means to the bottom of disc 60 surrounding finger 85 and being located in opening 88. Ring 89 prevents disc 86 from dislodging from groove 87 when it is snapped to the upper position C. Dome-shaped cylinder 90 is located between the two movable arms 99 and 100 of electrical switches 56 and 55 and has a rod 91 extending out from the cylinder sides adjacent the movable switch arms. Rod 91 of electrically non-conductive material is located immediately below each movable arm in such manner as to force switch arms 99 and 100 upwardly as cylinder 90 moves in the direction of arrow 92. Contact 65 will close and touch contact 62 as movable arm 99 moves upwardly. Likewise, contact 63 will close and touch contact 64 as movable arm 100 moves upwardly. The dome-shaped portion of cylinder 90 rests against the bottom center of snap disc 86. The bottom of cylinder 90 has a recess for receiving finger 94 of movable member 95 whereby cylinder 90 and member 95 form a movable structure. An opening 96 is provided in the bottom of box 57 allowing cylinder 90 and finger 94 to slide within. The upraised bottom portion 58 of container 31 has an opening for allowing finger 94 to slide in the direction of arrows 92 or 93. A circular base 98 is integrally connected to the bottom of finger 94 and rests on the top surface of diaphragm 37. Member 95 fits within upper chamber 52 formed between diaphragm 37 and upper edge portion 58. Chamber 52 is circular, as viewed looking in the direction of arrow 92, with an upper flat wall 102 having a diameter greater than the diameter of base 98. Flat portion 38 extends around chamber 52 being integrally connected to wall 102 by annular sloping wall 103. Likewise, chamber 53 is formed between diaphragm 37 and a circular recess in the top member 27. Chamber 53 has a circular flat bottom with an annular sloping side 105.

OPERATION

Element protector 23 prevents electrical energy from flowing to heater element 24 when insufficient water exists within the water heater to force water out through exit pipe 16 for moving member 95 upwardly. Thus, damage to the heater element is prevented which could otherwise occur as a result of insufficient water being within the tank to absorb the heat generated by the element.

FIG. 4 shows an electrical schematic of the element protector connected between the element and source of power. 220 volts alternating current is connected through fuses 29 and 30 across contacts 62–65 of protector 23 to heater element 24 via terminals 25 and 26. Electrical energy is prevented from flowing through heater element 24 when the contacts of the element protector 23 are in the open position. When the contacts of the element protector are in the closed position, contact 65 mates with contact 62 and contact 63 mates with contact 64 thus, allowing the electrical energy to flow from the 220 volt AC power source to the heater element. The closing and opening of the contacts is controlled by water moving into and out of chamber 53.

FIG. 3 shows the condition when the water heater does not contain sufficient water within tank 12 so as to force water out through exit pipe 16. Therefore, sphere 47 rests on the bottom of chamber 46 and member 95 rests on top of diaphragm 37. In addition, the electrical switches are in the normally open position and electrical energy is prevented from flowing to the heater element. As water enters tank 12 via pipe 15, the water level in tank 12 will gradually rise. Eventually, water will exit pipe 16, passing through coupling 17 and into tube 45. Chamber 46 will then fill with water forcing sphere 47 in the direction of arrow 92 until the sphere seats on O-ring 48 thereby sealing tube 49 from chamber 46. Pressure will then be applied to member 95 in the direction of arrow 92 only when water has exited tank 12 forcing sphere 47 against O-ring 48. Air pressure will escape out tube 49 without applying force to member 95 unless water has covered element 24 and has entered chamber 46 forcing sphere 47 to seat on the O-ring. Therefore, to insure that the protector will activate only after element 24 is beneath the tank water level line, the exit pipe 16 should extend down to a point near the top of element 24. As the water pressure within chamber 46 increases, the water will move in the direction of arrow 92 through tube 50 and into chamber 53. Eventually, the pressure in chamber 53 will be sufficiently great so as to force diaphragm 37 and member 95 in the direction of arrow 92 and thereby forcing

cylinder 90 and rod 91 upwardly, closing contacts 62–65 and 63–64.

As an example of one embodiment of the element protector, let us assume that spring 80 exerts 6 pounds of force on element 83 regardless of the position of disc 86. Let us further assume that disc 86 will snap from one position to another position when 4 pounds of force are applied to the disc. Thus, disc 86 will snap from the O position to the C position when cylinder 90 applies at least 10 pounds of force, 6 pounds to overcome the force exerted by spring 80 and 4 pounds of force to overcome the internal resistance of disc 86, to the bottom of the disc 86 in the direction of arrow 92. Likewise, disc 86 will snap from the C position to the O position when cylinder 90 applies 2 pounds of force or less to the bottom of the disc since spring 80 via element 83 will apply 6 pounds of force in the direction of arrow 93 to the top of the disc overcoming the internal disc resistance of 4 pounds. Further let us assume that tank 12 is empty. Thus, insufficient pressure will exist in chamber 46 and 53 to force member 95 in the direction of arrow 92 and disc 86 will be in the O position as shown in FIG. 3. In addition, contact 65 will not be touching contact 62, and contact 63 will not be touching contact 64 thus preventing flow of electrical energy to heater element 24.

As water enters tank 12 via pipe 15, the water level within the tank will increase until eventually the heater element 24 is immersed in water. As water is added to tank 12, water will eventually exit pipe 16 and enter coupling 17. Further increases in the water pressure within tank 12 will force water to enter chamber 46 of protector 23 via tube 45. Sphere 47 will float to the top of chamber 46 as the water level within the chamber increases. Tube 49 is provided to allow any trapped air to escape. Tube 49 will be sealed from the chamber when the water level within the chamber is sufficient to force sphere 47 to seat on O-ring 48. Further increases in the pressure within tank 12 will force water up tube 50 and into chamber 53. Member 95 rests on diaphragm 37 having finger 94 fitting into the bottom of cylinder 90. Of course, the top portion of cylinder 90 abuts disc 86 which has finger 85 of element 83 resting on its top surface. As previously mentioned, rod 91 extends through cylinder 90 at a point immediately below the two arms of electrical switches 55 and 56. In the present example, disc 86 will snap from the O position to the C position when at least 10 pounds of force is applied to the bottom of the disc. Thus, if the area of diaphragm 37 exposed to chamber 53 is 1 square inch, for example, when the pressure within lower valve chamber 53 equals or exceeds 10 pounds per square inch, diaphragm 37 and member 95 will move in the direction of arrow 92 forcing cylinder 90 to snap disc 86 from the O to the C position. As cylinder 90 moves in the direction of arrow 92, rod 91 abutting movable arms 99 and 100 will force the arms upwardly thus forcing contact 65 to touch contact 62 and contact 63 to touch contact 64. Electrical energy is thus routed through the contacts from the power source to the heater element.

Electrical switches 55 and 56 will stay in the closed position until the pressure within chamber 53 is less than or equals 2 pounds per square inch. Thus, electrical energy will be provided to the heater element and will not be interrupted as a result of variations of pressure within tank 12 unless the pressure decreases to the point when the pressure within chamber 53 is less than or equals 2 pounds per square inch. Spring 80 will apply sufficient force via element 83 to disc 86 forcing the disc to the O position and also forcing cylinder 90 to move in the direction of arrow 93 when the pressure within chamber 53 equals or is less than 2 pounds per square inch. In addition, as cylinder 90 moves in the direction of arrow 93, switches 55 and 56 will revert to their normally open positions with arms 99 and 100 moving downwardly providing for electrical contacts 62 through 65 to assume an open position interrupting the flow of electrical energy to heater element 24.

Many variations in the above described structure are contemplated within the scope of the present invention. For example, a variety of different discs 86 and springs 80 may be used requiring different levels of pressure to force the disc or spring from one position to another position. Of course, spring 80 will apply a different amount of force to element 83 depending upon the space within which the spring is contained. Spring 80 will apply a force greater than 6 pounds if spacer 79 is adjusted downwardly by screw 77. Likewise, spring 80 will apply less than 6 pounds if screw 77 is adjusted upwardly allowing spacer 79 to move up. Protector 23 may be used in a variety of locations on water heaters, as long as it is above the heater element.

It will be evident from the above description that the present invention provides an apparatus for preventing the flow of electrical energy to a heater element within a water heater when insufficient water is in contact with the heater element to absorb the heat generated by the element. It will be further evident from the above description that the present invention provides a reliable heater element protector which may be easily attached to a water heater. The description and drawings herein should be considered as illustrative and not restrictive as variations can be made within the scope of the invention.

The invention claimed is:

1. Protector apparatus for the electric heater element of a liquid storage and heating tank and comprising:
- a closed liquid storage tank having an electric heating element therein and having an inlet for flowing water under pressure thereinto;
- mounting means readily connectable to a liquid conduit fitting of said tank, said mounting means being located externally of said tank;
- a float chamber on said mounting means and communicating with said fitting, said chamber having a vent to atmosphere and having a float therein operable upon flotation by liquid to close said vent, said chamber being disposed above the elevation of said element and receiving liquid from said tank only when said element is below the surface level of the liquid in said tank;
- electric switch means on said mounting means and normally open during absence of pressure in said tank;
- switch operator means coupled to said switch means and communicating with said chamber and operable in response to attainment of a predetermined moderate positive gauge pressure in said chamber to close said electric switch means.

2. The apparatus of claim 1 wherein:
- said mounting means include pipe threads connectable to standard pipe fittings.

3. The apparatus of claim 1 wherein:
- said switch operator means is operable in response to a predetermined positive gauge pressure in said chamber somewhat lower than said moderate pressure to open said electric switch means.

4. The apparatus of claim 3 wherein:
- said switch operator means has a movable structure for operating said electric switch means, and a diaphragm supporting said structure and sealably covering a cavity connected to said chamber; and
- said diaphragm receives pressure from said chamber via said cavity and transmits force to said movable structure to operate said electric switch means.

5. The apparatus of claim 4 and further comprising:
- a spring on said mounting means; and
- an element having a first and second given configuration being reversibly changeable from the one configuration to the other configuration by force.

6. The apparatus of claim 5 wherein:
- said element changes configuration as a result of force applied from said movable structure and said spring, thereby allowing said movable structure to operate said electric switch means.

7. The apparatus of claim 6 and further comprising:
- adjusting means for changing the force applied by said spring to said element.

8. The apparatus of claim 7 and further comprising:

a container for housing said electric switch means;
a hydraulic assembly for housing said float chamber and float;
said diaphragm being fastened between said container and said hydraulic assembly.

* * * * *