

Feb. 20, 1968

T. F. E. FUCHSLOCHER
ELECTRIC FLUID HEATER

3,370,154

Filed June 29, 1964

3 Sheets-Sheet 1

FIG. 1

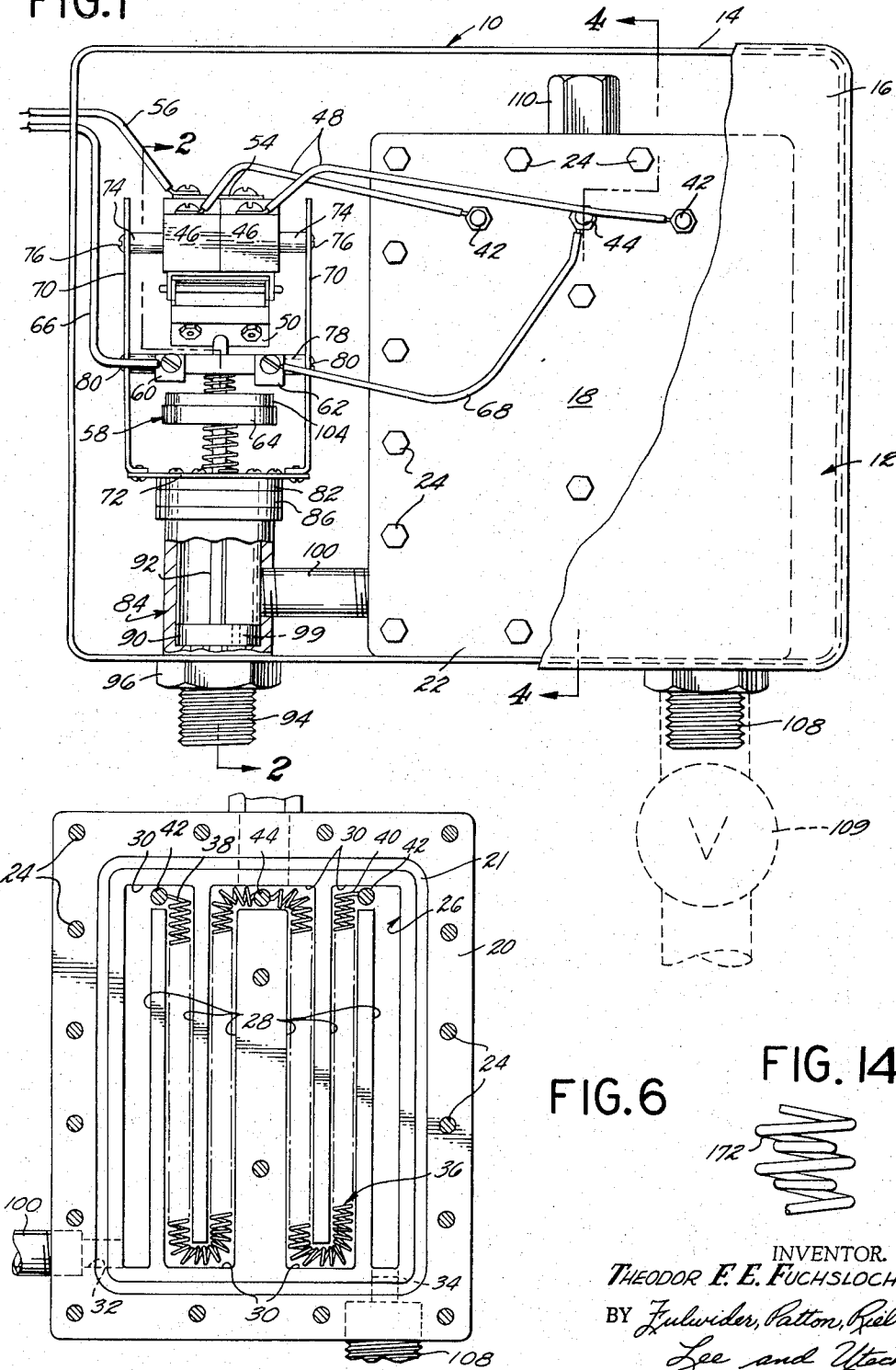
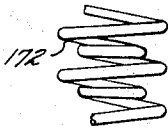


FIG. 6

FIG. 14



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3 Sheets-Sheet 2

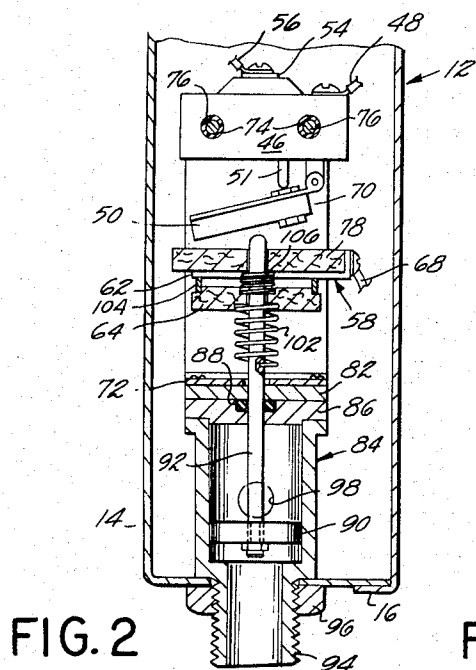


FIG. 2

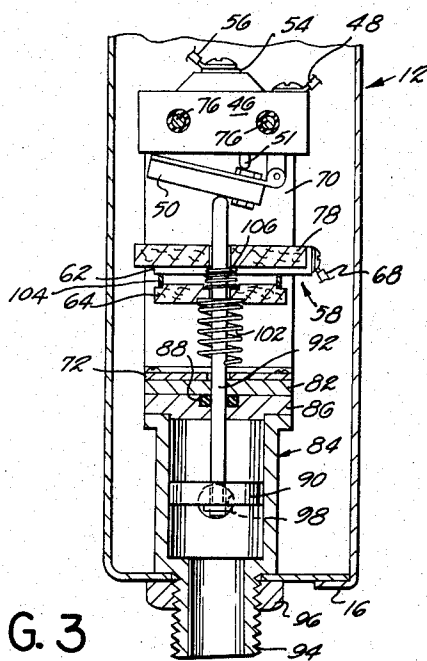


FIG. 3

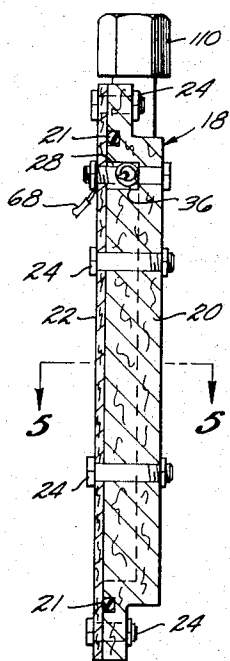


FIG. 4

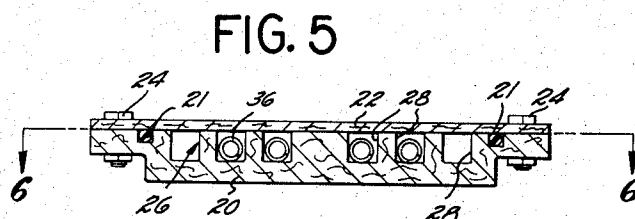


FIG. 5

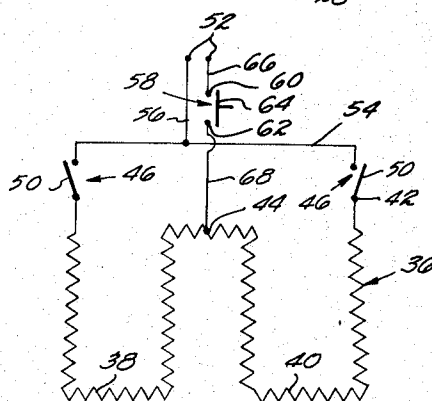


FIG. 7

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ELECTRIC FLUID HEATER

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3 Sheets-Sheet 3

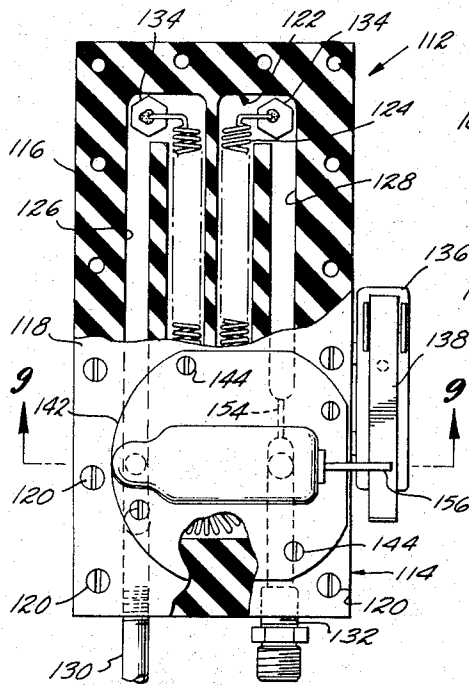


FIG. 8

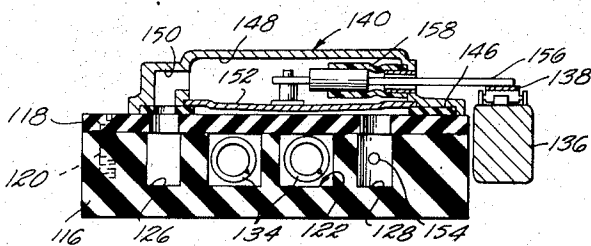


FIG. 9

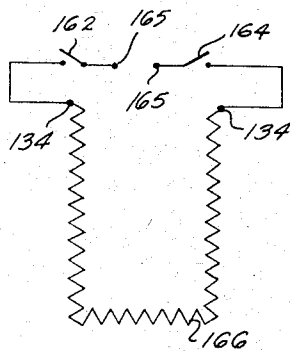


FIG. 10

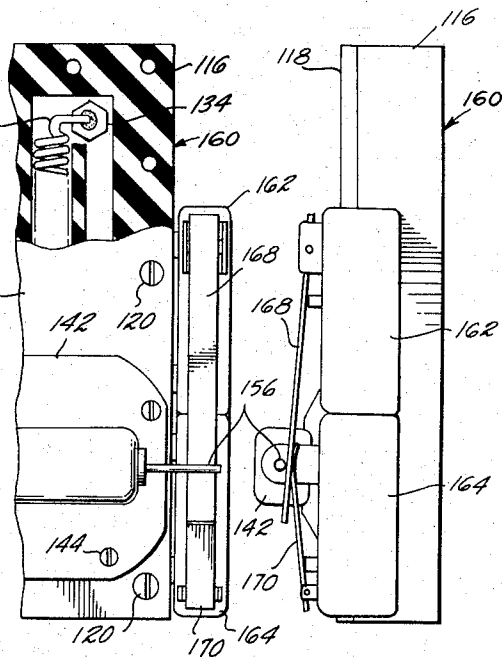


FIG. 11

FIG. 12

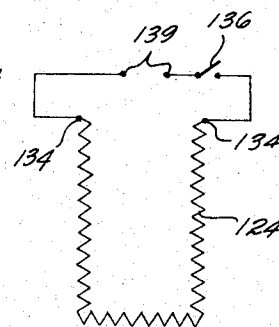


FIG. 13

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3,370,154

ELECTRIC FLUID HEATER

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7 Claims. (Cl. 219—309)

The present invention relates to a fluid heater, and more particularly to a fluid heater in which continuously flowing water is raised in temperature.

Water heaters of the type commonly referred to as "instant" water heaters direct incoming cold fluid through some form of heating means which raises the temperature of the water to the desired point, and the heated water is then discharged directly to the point of use without any intermediate storage tank or the like. Such heaters are designed to operate only when water is flowing through them, and the means for preventing heat generation during periods of no flow consequently must be extremely reliable for safety reasons. One well known type of electrical water heater effects heating by conduction of electrical currents through the water, with the water acting as a resistance. The water is constrained to flow between spaced-apart electrodes for this purpose and when there is no flow there is of course no heating. However, since waters in various geographical regions differ in mineral content, and therefore have different electrical resistance characteristics, it has been difficult if not impossible to provide a simple and inexpensive means for insuring that these various different waters will be raised to approximately the same temperature with a given voltage supply.

In addition, where it is desired to raise the temperature of relatively large volumes of flowing water to provide hot water at the heater outlet, relatively heavy electric currents are required. In such situations, heaters of the prior art conventionally utilize heavy, rugged switches resistant to the arcing and contact deterioration attendant switch interruption of heavy current flow, but such switches are relatively expensive and undesirably raise the cost of the heater unit to a point where such units do not have widespread consumer appeal. Moreover, despite the heavy, rugged nature of such switches, their service life is nevertheless undesirably limited by the contact deterioration over a period of time.

Instant water heaters of the prior art, whether adapted to handle heavy or light amperages, have also been found to be unsatisfactory with respect to the means provided for energizing and de-energizing the heating element or elements quickly and reliably and in accordance with water flow conditions.

Prior art water heaters are also often subject to undesirable current leakage from the electrodes to the water being discharged from the heating unit outlet, sometimes shocking the consumer using the water.

Accordingly, it is an object of the present invention to provide a fluid heater adapted to rapidly raise the temperature of flowing water in a safe and reliable manner to provide hot water at the heater outlet, thereby eliminating any need for a hot water storage tank. With such a fluid heater the heat loss attendant conventional hot water systems by reason of heat radiation from hot water taps and pipes is substantially prevented. In addition, there is eliminated the waste of cold water which often occurs when the consumer runs the water for some time to obtain hot water at the tap.

Another object of the invention is the provision of a fluid heater which includes a flow-responsive device and an electrically resistive heating element which is energized only when the flow-responsive device is operated by water flowing into the heater. With this arrangement, heating

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is provided only when water is flowing, and the water is heated relatively uniformly, regardless of its electrical conductivity, because the water is constrained to flow in and about the electrically resistive element for its heating instead of itself constituting the resistive or heating medium. The temperature of the water emanating from the hot water tap is adjusted merely by opening and closing a water tap or valve to regulate the rate of flow through the heater, although other means of flow regulation could also be utilized. In addition, the fluid heater is characterized by non-responsiveness of the flow-responsive device to very low rates of water flow so that, for example, the outlet faucet will not drip scalding water.

Another object of the invention is the provision of a fluid heater of the aforementioned character which in its several embodiments is adapted to operate without the use of heavy duty, relatively expensive switching elements. In one embodiment for relatively high current loads, a primary switch is connected to one side of the power source and a plurality of light, inexpensive secondary switches are connected to the other side of the power source to complete the heating circuit. The heating element is divided into branches connected in parallel with a secondary switch for each branch of the parallel circuit. The circuit is completed only upon closure of the secondary switches to thereby greatly reduce arcing and contact deterioration. Other embodiments of the invention provide switching arrangements which are adapted to open the heating circuit to isolate the heating element from the power source, and which are further adapted to close such heating circuit only when there is appreciable water inlet pressure.

Yet another object of the invention is to provide a fluid heater of the aforementioned character which can be connected directly to a source of cold water to provide heated water, and wherein the flow of heated water is controlled merely by operating a faucet valve or the like at the outlet from the heater.

Another object of the invention is to provide a fluid heater of the aforementioned character in which the components thereof are relatively inexpensive to manufacture, compact, easy to maintain and operate, and characterized by long and reliable service life.

Other objects and features of the invention will become apparent from consideration of the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is an elevational sectional view of a fluid heater according to the present invention, a portion of the outer housing thereof being cut away for clarity;

FIG. 2 is a transverse cross-sectional view taken along the line 2—2 of FIG. 1, and showing the components subsequent operation of the primary switch;

FIG. 3 is a view substantially identical to FIG. 2, but showing the components thereof subsequent actuation of both the primary switch and the plurality of secondary switches;

FIG. 4 is a transverse cross-sectional view taken along the line 4—4 of FIG. 1;

FIG. 5 is a view taken along the line 5—5 of FIG. 4;

FIG. 6 is a view taken along the line 6—6 of FIG. 5;

FIG. 7 is an electrical wiring diagram of the circuitry of the fluid heater of FIG. 1;

FIG. 8 is an elevational view of a second embodiment of a fluid heater according to the present invention, a portion of the cover plate thereof being cut away for clarity;

FIG. 9 is a transverse cross-sectional view taken along the line 9—9 of FIG. 8;

FIG. 10 is an electrical wiring diagram of the circuitry of the fluid heater of FIGS. 11 and 12;

FIG. 11 is a partial elevational view similar to FIG. 8, but showing a third embodiment of a water heater according to the invention;

FIG. 12 is a side elevational view of the embodiment of FIG. 11;

FIG. 13 is an electrical wiring diagram of the circuitry of the fluid heater of FIGS. 8 and 9; and

FIG. 14 is a detail view of an alternative form of electrically resistive heating element adapted for use in any of the embodiments of the fluid heater according to the invention.

Referring now to the drawings, and particularly to FIGS. 1 through 3 thereof, there is illustrated a fluid heater 10 comprising a hollow exterior covering or housing 12 constituted of a main portion 14 and a cover 16 stamped out of sheet material such as sheet metal.

A water jacket or casing 18 of substantially rectangular configuration is located within the hollow interior of the housing 12 and comprises a base 20 and a cover 22, both of which are preferably cast or formed of electrical and heat insulating material such as resin-impregnated glass fiber material or the like. The base 20 and cover 22 are joined together by a plurality of bolt and nut assemblies 24, an O-ring 21 being interposed therebetween to provide a fluid-tight assembly.

The casing 18 defines an internal chamber or passageway 26 constituted of a plurality of elongated, parallel grooves 28 joined at their extremities by connecting grooves 30. More particularly, the lower ends of one pair of adjacent grooves 28 is connected by a connecting groove 30, and the upper end of one of these grooves 28 is connected to the upper end of the next adjacent groove 28 by another connecting groove 30, and so on, so that the passageway 26 is characterized by a serpentine configuration in which the lower end of each of the elongated grooves 28 is connected to the lower end of one of the pair of grooves 28 adjacent to it, and is connected at its upper end to the upper end of the other of the two adjacent grooves 28.

As best illustrated in FIG. 6, the casing 18 includes an inlet 32 adjacent one extremity of the passageway 26 for incoming cold fluid, and an outlet 34 adjacent the opposite extremity of the passageway 26 for outgoing heated fluid.

Electrical heating means in the form of an elongated, helically coiled electrically resistive element 36 is disposed within the passageway 26 and extends through at least a portion thereof. It is particularly noted that the passageway grooves 28 adjacent the inlet 32 and the outlet 34 preferably do not contain any portion of the heating element 36, the reasons for this arrangement being set forth in greater detail hereinafter.

The particular material of which the heating element 36 is made does not constitute a part of the present invention except that it should be one of the commercially available materials adapted to withstand high temperatures and possible oxidation resulting from exposure to water.

As will be seen, water to be heated flows through the passageway 26, through and about the heating element 36, and is raised in temperature upon energization of the heating element 36. Consequently the cross-sectional area of the heating element 36 should be relatively small so as not to unduly impede the flow of water through the passageway 26, and for this purpose is preferably constituted by a coiled wire or the like.

The heating element 36 is divided into a pair of resistive branches or legs 38 and 40, as best illustrated in FIGS. 6 and 7, by a pair of end terminals 42 which are provided in the casing 18 and are attached to the ends of the heating element 36, respectively, and by a middle terminal 44 provided in the casing 18 and connected to the heating element 36 at a point approximately midway between the extremities thereof. The terminals 42 and 44 protrude through the top of the casing 18 for

connection of suitable electrical leads, as will be seen. Thus, the resistive leg 38 is defined by the heating element portion lying between one end terminal 42 and the middle terminal 44 and the other resistive leg 40 is defined by the heating element portion lying between the other end terminal 42 and the middle terminal 44.

A pair of usual and conventional single pole, single throw secondary switches 46 of the normally open type are connected by electrical leads 48 to the end terminals 42, respectively. The switches 46 are preferably the well known "snap-action" type sold under various trademarks, including the trademark "Micro Switch" of Minneapolis-Honeywell Regulator Company. Such switches are readily available, relatively inexpensive, and adapted to handle relatively low levels of current. If desired, the two switches 46 could be incorporated in one double pole type of switch, as will be apparent.

As best illustrated in FIGS. 1 through 3, the secondary switches 46 are simultaneously actuated by a common lever 50 which is pivotally mounted to the casings of the switches 46. Upward movement of the lever 50, as viewed in FIGS. 2 and 3, effects upward or inward movement of the switch pin plungers 51 and closes the normally open switches 46. As previously indicated, one side of each switch 46 is connected by a lead 48 to one of the resistive legs 38 or 40, as the case may be, and the opposite sides of the switches 46 are connected together by an electrically conductive strap 54, as best seen in FIG. 1 and diagrammatically indicated in FIG. 7.

A lead 56 from a suitable power source 52 is connected to the strap 54 so that the resistive legs 38 and 40 are connected in a parallel circuit which is itself connected to one side of the power source 52. Each leg or branch of the parallel circuit includes one of the secondary switches 46, and this parallel circuit is connected to the other side of the power source 52 through a normally open primary switch 58.

More particularly, the primary switch 58 includes fixed contacts 60 and 62 and a contactor 64 which is movable to simultaneously engage the contacts 60 and 62 and operate the switch 58. The fixed contact 60 is connected to the power source 52 by an electrical lead 66, and the other fixed contact 62 is connected to the middle terminal 44 by an electrical lead 68 so that upon operation of the switch 58 the parallel circuit of the resistive legs 38 and 40 is connected in series with the power source 52 for energization of the heating element 36.

The side-by-side secondary switches 46 and the primary switch 58 are mounted in operative position by a U-shaped metal bracket which includes side portions 70 suitably connected at their lower extremities by a bottom plate or portion 72. The two switches 46 are fastened together both by the strap 54 and by the pivot shaft for the lever 50. In addition, a pair of bushings 74 are interposed between the sides of the switches 46 and the adjacent side portions 70, and receive a pair of machine screws 76 or the like which are disposed through openings in the side portions 70. The screws 76 are threaded into openings (not shown) in the switches 46 to secure the switches in position.

The fixed contacts 60 and 62 of the primary switch 58 are mounted in spaced-apart relationship upon a transversely disposed plate 78 which is made of electrical insulating material, and the sides of this plate are threaded to receive a plurality of screws 80 for securing the plate to the side portions 70.

The contactor 64 is preferably centrally apertured and circular in configuration and includes a main portion made of electrical insulating material, and also an annular contactor ring 104 carried by the main portion and made of copper or the like for completing a circuit through the contacts 60 and 62 upon engagement therewith.

The frame carrying the switches is secured in spaced, insulated relationship relative to adjacent portions of the housing 12 by securement of the bottom portion 72 there-

of to a centrally apertured circular plate 82 forming an upper closure for a cylinder 84.

The cylinder 84 includes a centrally apertured seal receiving plate 86 which is located between the plate 82 and the upper end of the cylinder 84 and provided with an annular recess for receiving a seal or O-ring 88. The cylinder 84 axially slidably receives a piston 90 in loose-fitting relationship, and the piston rod 92 thereof is slidably disposed through the central apertures of the plates 82 and 86, with the O-ring 88 providing a fluid-tight relationship.

The upper extremity of the piston rod 92 is slidably disposed through the central apertures of the contactor 64 and the insulating plate 78 for engagement with the switch lever 50 to operate the switches 46 upon upward movement of the piston 90.

The lower end of the cylinder 84 includes a threaded, reduced diameter portion 94 which receives a nut 96 to rigidly secure the cylinder 84 in position on the housing 12, and consequently fix the switches 46 and 58 in proper position relative to the housing 12. In addition, the threaded portion 94 provides a means for coupling the heater 10 directly to a source of cold water so that the piston is exposed to line water pressure.

In FIG. 2 the piston 90 is illustrated in its normally closed position below an outlet opening 98 which is provided in the side wall of the cylinder 84. The thickness of the piston 90 is less than the diameter of the opening 98 to avoid any possibility of the piston ever assuming a "dead-center" position which would block the opening 98. In addition, the piston 90 includes a by-pass opening 99, as best seen in FIG. 1, which has two functions. First, it allows water above the piston to escape to thereby permit the piston to move upwardly to an open position beyond or above the outlet opening 98 in the presence of appreciable water flow through the lower portion of the cylinder 84. Second, it permits a comparatively low rate of water flow to pass through the heater without actuating the primary switch 58 and secondary switches 46. With this arrangement a dripping outlet faucet for example, will not drip scalding water.

Water coming from the cylinder 84 passes through the outlet opening 98 and into the casing inlet 32 by means of a coupling 100 which is connected between the cylinder outlet 98 and the casing inlet 32.

The underside of the main portion of the contactor 64 includes a recess for seating one end of a helical compression spring 102, and the opposite end of the spring is disposed through a suitable opening in the rod 92 so that upon upward movement of the rod 92, the rod carries the lower end of the spring 102 with it. The contactor 64, supported by the upper end of the spring 102, also moves upwardly and the ring 104 thereof engages the pair of fixed contacts 60 and 62 for operating the primary switch 58. As the upward movement of the rod 92 continues, the spring 102 compresses and the upper end of the rod 92 then engages the lever 50 to operate the secondary switches 46.

A second helical compression spring 106 is interposed between the contactor 64 and the underside of the plate 78 and provides a bias for insuring disengagement between the contactor ring 104 and the pair of fixed contacts 60 and 62 when the piston rod moves to its normally closed position.

From the foregoing it will become apparent that the contactor 64 bridges the fixed contacts 60 and 62 prior to operation of the pair of secondary switches 46 by the upper end of the piston rod 92, and that on the return stroke of the piston 90, the switches 46 are first opened, followed by opening of the primary switch 58. This switching sequence, together with the parallel circuit of the resistive legs 38 and 40, permits the use of relatively low capacity switches for the secondary switches 46. Each switch 46 only handles half the amperage which would otherwise have to be handled by a single switch.

The primary switch 58 carries the full amperage, but arcing on closing and opening does not occur by reason of the making and breaking of the circuit by the switches 46.

In operation, the fluid heater 10 is coupled to the power source 52, such as a 220 volt alternating current source, and the heater preferably hung under a kitchen sink or the like for connection of the threaded portion 94 thereof to the cold water supply pipe. The outlet 34 from the heater 10 is connected to a threaded coupling 108 which is in turn connected to a valve or hot water faucet 109 for discharge of heated water at the point of use. When the water faucet 109 is opened, the pressure differential causes movement of the piston 90 to its open position above the outlet opening 98, and incoming cold water passes through the inlet 32 and into the passageway 26 for heating. The upward movement of the piston 90 effects operation of the primary switch 58, followed by simultaneous operation of both the secondary switches 46, and the heating element resistive legs 38 and 40 are thereby connected in parallel circuit and to the power source for energization. The heated water then passes from the passageway 26 through the faucet 109 for use, as will be apparent.

A usual and conventional pressure relief valve 110 is threadably mounted within a suitable opening in the casing 18 in communication with the passageway 26 and, as is well known, provides for venting of excessively high pressures.

The spaces between the ends of the heating element 36 and the inlet and outlet 32 and 34 increase the resistance paths from the terminals 42 to the exterior of the casing 18, thereby greatly reducing current leakage to the external plumbing fittings 94 and 108.

The portion 94 at the heater inlet and the threaded coupling 108 at the heater outlet are electrically connected together by the metal housing 12. In the event that the housing 12 is made of an electrically non-conductive material, the portion 94 and coupling 108 are preferably connected together by a conductive strap or the like to equalize the electrical potential therebetween and thereby prevent electrolysis from occurring within the heater.

The fluid heater 10 above-described is particularly adapted for use with relatively heavy currents, the primary switch 58 and the secondary switches 46 being adapted to handle, for example, 40 amperes of current at 220 volts, 20 amperes being carried in each of the legs or branches 38 and 40 of the heating element 36. Referring now to FIGS. 8 through 10, there is illustrated a fluid heater 112 according to the present invention, which is adapted to handle lower current levels, such as 20 amperes of alternating current at 110 volts, and which utilizes only a single switch for opening the 110 volt heating circuit.

The fluid heater 112 operates in a fashion similar to the fluid heater 10, and is carried in a similar housing (not shown) to protect the components from tampering or the like. The fluid heater 112 utilizes, generally, a substantially rectangular water jacket or casing 114 which includes a base 116 and an overlying cover 118, both the base and cover preferably being made of an electrical and heat insulating material. The base and cover are joined together by a plurality of machine screws 120 or the like.

The casing 114 defines an internal chamber or passageway 122 characterized by a serpentine configuration and having a U-shape middle portion in which a helically wound resistive element 124 is disposed. The upper ends of the U-shaped portion of the passageway 22 are in communication with a reversely oriented pair of branch passages 126 and 128 which do not have any resistive element therein and which extend to the base of the casing 114 for connection to an outlet conduit 130 and an inlet conduit 132, respectively. The outlet conduit 130 is connected to a suitable hot water faucet or valve (not shown) for adjusting the flow of heated fluid from the

heater 112, as described above in connection with the operation of the hot water outlet valve 109. The inlet conduit 132 is connected to the cold water supply.

The upper ends of the resistive heating elements 124 are electrically connected to conductive terminals 134 which extend through the casing 114 and are coupled by a pair of electrical leads (not shown) to opposite sides of a usual and conventional "snap-action" type of switch 136 sold under various trademarks, such as the trademark "Micro Switch" of Minneapolis Honeywell Regulator Company. The switch 136 is a conventional single pole, single throw, normally open type whose internal contacts are closed to complete the circuit from a source of power to the resistive element 124 by actuation of a lever 138 pivotally mounted to the switch casing. The switch 136 is secured to the side of the heater casing 114 in any suitable manner, as best illustrated in FIG. 9.

The circuitry of the fluid heater is shown in FIG. 13, wherein it is seen that closure of the switch 136 completes a circuit from a pair of power terminals 139 to the heating element 124, which is in series with the switch 136.

The switch 136 is actuated only when there is an appreciable flow of water through the inlet conduit 132, as sensed by a pressure-responsive actuator or device 140. More particularly, the pressure-responsive device 140 comprises a generally circular diaphragm housing 142 secured to the casing cover 118 by a plurality of machine screws 144, a gasket 146 or the like being interposed between the heater casing 114 and the housing 142 to provide a fluid-tight relationship therebetween.

The housing 142 is formed to provide a semi-cylindrical portion which defines an elongated chamber 148 extending across the width of the casing 114 with one extremity located adjacent the branch passage 128 and the opposite extremity connected to the branch passage 126 by a passageway 150 provided in the diaphragm housing 142. Suitable openings are provided in the gasket 148 and in the casing cover 118 to afford fluid communication from the chamber 148 to the branch passages 126 and 128.

A flexible element or diaphragm 152 is carried at its edges by the diaphragm housing 142 in spaced relation to the upper surface of the casing cover 118 to permit fluid communication between the underside of the diaphragm 152 and the branch passage 128. The diaphragm 152 blocks passage of fluid from the branch passage 128 to the chamber 148, but fluid from the branch passage 126 is permitted to enter the chamber 148 through the passageway 150 whereby the pressures in the chamber 148 and the hot water discharge conduit 130 are essentially the same.

The branch passage 128 downstream of the diaphragm housing 142 includes a reduced by-pass passage 154, as best viewed in FIG. 8, which under line pressure permits a flow of water sufficient to supply an adequate quantity of heated water from the outlet conduit 130. In addition, the restriction 154 also creates a pressure difference which causes upward deflection of the diaphragm 152 upon opening of the outlet hot water faucet (not shown). However, in the absence of line pressure the passage 154 permits a relatively low rate of flow without causing a pressure drop sufficient to upwardly deflect the diaphragm 152. With this arrangement the hot water faucet can drip or be opened very slightly without energization of the heating element, as will be seen, so that the water is not discharged at scalding temperatures.

When the diaphragm 152 is deflected upwardly, a diaphragm rod 156 attached thereto is pivoted to actuate the switch arm 138 and thereby operate the switch 136. The pivotal action of the rod 156 is afforded by a resilient sleeve 158 mounted upon the rod 156 and carried by the housing 142.

Referring now to FIGS. 11, 12, and 10, there is illus-

trated a fluid heater 160 constituting a third embodiment of the present invention. The heater 160 is substantially identical in every respect to the fluid heater 112 except that the heater 160 utilizes 220 volt alternating current, has a capacity four times that of the heater 112, and includes a pair of switches 162 and 164 located on opposite ends of a heating element 166 for opening the electrical connection between the ends of the element 166 and the opposite sides of the power source. More particularly, as best seen in FIG. 10, the pair of switches 162 and 164 are each arranged between opposite ends of the element 166 and a pair of power terminals 165, respectively. The switches 162 and 164 are in series with the heating element 166 and in their open positions interrupt the circuit between the element 166 and the opposite sides of the power source, as illustrated. The switches in the embodiment illustrated each handle approximately 20 amperes of current at a level of approximately 220 volts.

Both switches 162 and 164 are actuated simultaneously by the rod 156 of the pressure-responsive device 140 through a double arm arrangement best seen in FIG. 12. That is, the pair of switches 162 and 164 are arranged in end-abutting relationship with the pivotally mounted switch arms or levers 168 and 170 thereof extending toward each other and beneath the diaphragm rod 156. The lever 168 is comparatively long and engages the underside of the diaphragm rod 156 and the upper side of the switch lever 170 so that upon downward deflection of the diaphragm rod 156, the lever 168 is moved downwardly and, in its downward movement, effects downward movement of the lever 170. Simultaneous actuation of both switches 162 and 164 is effected by suitable adjustment of the positions of the levers 168 and 170 relative to the usual switch buttons or pins of the switches.

Referring now to FIG. 14, there is illustrated a configuration of heating element 172 which is adapted for use in any of the several embodiments above-described. The heating element 172 is particularly adapted to occupy a minimum space in the fluid passageway within which it is disposed while yet offering a maximum heating surface in contact with the water. Each loop or turn of the heating element 172 is actually constituted by a larger diameter outer loop which is continued to form an interior loop. The interior loop is helically continued to form another outer loop below the first outer loop, the winding arrangement then being continued to form a second interior loop and so on. The opposite extremities of the heating element 172 are preferably placed under tension in order to insure that the various loops are out of electrical engagement with one another.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means including a plurality of secondary switches operative to couple different portions of said heating means in parallel circuit with one another, and including a primary switch operative to couple said parallel circuit with a source of electrical energy to energize said heating means;

and means responsive to fluid flow through said passageway to operate said primary switch and subsequently said secondary switches.

2. A fluid heater comprising:

a casing including electrical insulating means defining

a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means operative to couple different portions of said heating means in parallel circuit with one another and also operative to couple said parallel circuit in series with a source of electrical energy to energize said heating means;

and means coupled to said last-mentioned means and sequentially responsive to fluid flow through said passageway first to operate said last-mentioned means to couple said source and said parallel circuit and thereafter to operate said last-mentioned means to couple said different portions of said heating means in parallel circuit.

3. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

an elongated, helically wound electrically resistive heating element extending through at least a portion of said passageway;

means for connecting the mid portion of said heating element to one side of a source of electrical energy and including a primary switch;

means for connecting the opposite extremities of said heating element to the other side of said source of electrical energy and including a pair of secondary switches in series circuit with said opposite extremities respectively;

and means responsive to fluid flow through said passageway to operate said primary switch and subsequently said secondary switches to energize said heating element.

4. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means including secondary switch means operative to couple different portions of said heating means in parallel circuit with one another, and including primary switch means operative to couple said parallel circuit with a source of electrical energy to energize said heating means;

and means responsive to fluid flow through said passageway to operate said primary switch means and subsequently said secondary switch means.

5. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means including a plurality of secondary switch means operative to simultaneously couple different portions of said heating means in parallel circuit with one another, and including primary switch means having a fixed contact and a contactor movable to engage said fixed contact and operate said primary switch means and couple said parallel circuit with a source

of electrical energy to energize said heating means; means defining a cylinder having an open end in communication with a source of cold fluid and further having an outlet to said passageway;

a piston responsive to a pressure differential for movement from a normal closed position between said open end and said cylinder outlet, and at one side of said cylinder outlet, to an open position on the other side of said cylinder outlet whereby cold fluid is admitted to said inlet, said piston including a piston rod engageable with said secondary switch means for operation thereof upon location of said piston in said open position;

and a helical spring secured at one extremity to said piston rod and supporting said contactor at its opposite extremity whereby said contactor is movable with said piston rod to engage said fixed contact prior to engagement of said secondary switch means by said piston rod.

6. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means including a plurality of secondary switch means operative to simultaneously couple different portions of said heating means in parallel circuit with one another, and including primary switch means having a fixed contact and a contactor movable to engage said fixed contact and operate said primary switch means and couple said parallel circuit with a source of electrical energy to energize said heating means; means defining a cylinder having an open end in communication with a source of cold fluid and further having an outlet to said passageway;

a piston responsive to a pressure differential for movement from a normal closed position between said open end and said cylinder outlet, and at one side of said cylinder outlet, to an open position on the other side of said cylinder outlet whereby cold fluid is admitted to said inlet, said piston including a piston rod engageable with said secondary switch means for operation thereof upon location of said piston in said open position;

a first helical spring secured at one extremity to said piston rod and supporting said contactor at its opposite extremity whereby said contactor is movable with said piston rod to engage said fixed contact prior to engagement of said secondary switch means by said piston rod;

and a second helical spring interposed between said contactor and said fixed contact to insure disengagement therebetween upon movement of said piston to said closed position.

7. A fluid heater comprising:

a casing including electrical insulating means defining a fluid passageway, said casing including an inlet adjacent one extremity of said passageway for incoming cold fluid and an outlet adjacent the opposite extremity of said passageway for outgoing heated fluid;

electrical heating means extending through at least a portion of said passageway;

means including secondary switch means operative to couple different portions of said heating means in parallel circuit with one another, and including primary switch means operative to couple said parallel circuit with a source of electrical energy to energize said heating means;

and means automatically responsive to a change in state of fluid in said passageway to first operate said pri-

mary switch means and subsequently said secondary switch means.

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