

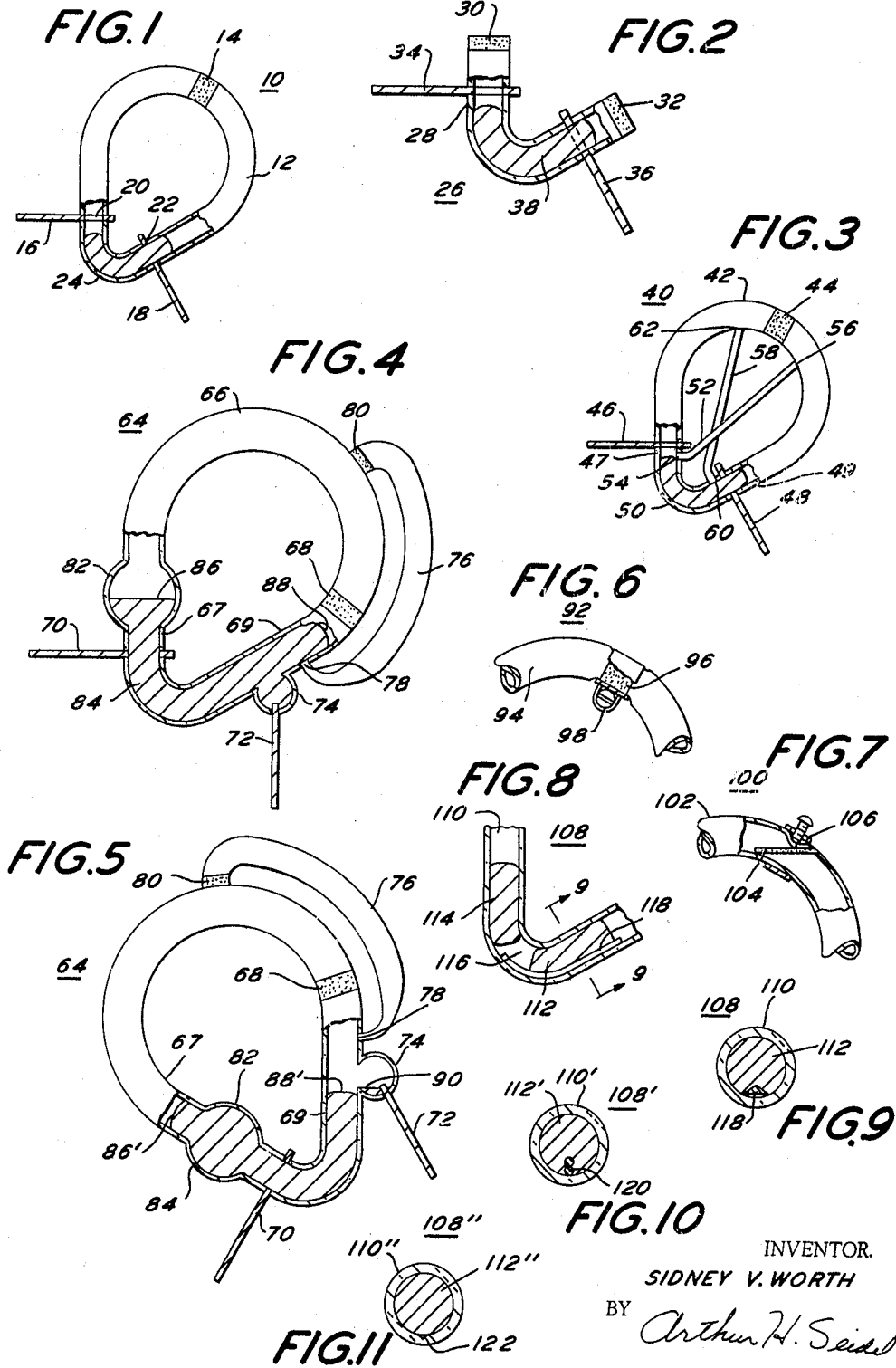
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MERCURY TIME DELAY SWITCHES

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MERCURY TIME DELAY SWITCHES

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This is a continuation-in-part of my copending patent application Serial No. 41,537 for a "Mercury Time Delay Switch," filed July 8, 1960.

In general, this invention relates to new and improved electrical switches and, more particularly, to electrical switches whose time delays for making and breaking can be varied in a simple and economical manner.

In utilizing the principles disclosed in the above-mentioned patent application, it was desirable to develop an electric switch whose design would permit mass production techniques. Additionally, the new switch would incorporate features which would give such versatility as to enable the switch to operate in a fast make, fast break mode in both directions; a slow make and a break mode in both directions; fast break, slow make; or any combination of these modes of operation with any number of contacts. Still further, the new switch should have good electrical contact between the conductive liquid in the switch and the terminals thereof, either by liquid to liquid contact or by providing a 360° surface area between a metal contact and the conductive liquid.

If mercury is utilized, an anti-bubble device should be included which would prevent the formation of bubbles and the breaking up of mercury into more than one "slug." The switch also should be designed to achieve maximum mercury head for any given position of the switch. Further, if possible, this head should be maintained substantially constant during switching operations. The switch should have variable time delays, which variations can be made either by changes during the initial manufacture or by changes after the switch has been built.

Therefore, it is the general object of this invention to achieve the foregoing and other desirable qualities by the provision of a new and better electric switch.

A further object of this invention is the provision of a simple and more economical electric switch which can be designed for any mode of operation.

A still further object is the provision of a new and less expensive electric switch utilizing a conductive liquid and a nonconductive fluid in which the time delay of the switch is controlled by the flow of the nonconductive fluid.

Another object of this invention is the provision of a new and better electric switch which obtains maximum cooling and arc suppression with excellent contact between the conductive liquid in the switch and the switch contacts.

Still another object of this invention is the provision of a new and better mercury switch which incorporates an anti-air bubble device for preventing the formation of air pockets within the mercury.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there are shown in the drawings forms which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a perspective view partially broken away of an electric switch built in accordance with the principles of the present invention.

FIGURE 2 is a perspective view partially broken away of a second embodiment of the present invention.

FIGURE 3 is a perspective view partially broken away of a third embodiment of the present invention.

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FIGURE 4 is a perspective view partially broken away of still another embodiment of the present invention.

FIGURE 5 is a perspective view of the switch of FIGURE 4 partially broken away with the switch in an off position.

FIGURE 6 is a partial perspective view of one means of varying the time delay of the switch in FIGURE 1.

FIGURE 7 is a partially cross section view of a second means of varying the time delay of electric switches built in accordance with the principles of the present invention.

FIGURE 8 is a cross sectional view of a switch incorporating one form of an anti-bubble device built in accordance with the principles of the present invention.

FIGURE 9 is a cross sectional view of the switch of FIGURE 8 taken along lines 9—9.

FIGURE 10 is a cross sectional view of a switch incorporating a second type of anti-bubble device.

FIGURE 11 is still another embodiment of an electric switch incorporating an anti-bubble device.

In FIGURE 1, there is shown a switch 10 built in accordance with the principles of the present invention. The switch 10 includes a pear-shaped annular body 12 which can be manufactured from plastic, glass, ceramic, or any other nonconductive material which would be suitable for the purpose. At the top of the switch, there is provided a time delay device 14 which has a plurality of minute holes therethrough for controlling the passage of the nonconductive fluid within the tube 12 from one side of the time delay device 14 to the other. The device 14 can be a ceramic, metal, or plastic frit which is porous and will allow the passage of the fluid therethrough. In the alternative, it can be a plate with tiny holes or the tube 12 could be constricted to a small passageway which would delay the travel of fluid from one side of the passageway to the other.

At the bottom of the pear-shaped tube 12, there are provided a pair of spaced contacts 16 and 18. The contacts 16 and 18 are flat thin pieces of metal having circular apertures 20 and 22 therein which conform to the inner diameter of the tube 12. Thus, the circular apertures 20 and 22 act to give 360° contact with the mercury 24 in the tube 12. As the contacts 16 and 18 are made thinner, the contact between mercury 24 and contacts 16 and 18 is accomplished with even more minimum travel of the mercury.

The mercury 24 is just sufficient to complete the circuit between contacts 16 and 18 when the switch 10 is in the on position. In FIGURE 1, the switch 10 is shown in the off position. Counterclockwise rotation of the switch 10 would bring the mercury into the on position.

By utilizing the pear shape, the leg of the tube 12 in which the mercury is moving downward is brought to a vertical position so that maximum mercury head is achieved during switching.

The remainder of the tube 12 is filled with a nonconductive gas or liquid. This nonconductive fluid is metered through the time delay device 14 when the switch 10 is rotated from the off position shown in FIGURE 1 to the on position in which mercury 24 bridges contacts 16 and 18. The nonconductive fluid in one preferred embodiment was hydrogen under fifty pounds per square inch pressure. This highly pressurized hydrogen is useful in insuring maximum cooling and arc suppression under heavy loads. As can readily be seen, the embodiment shown in FIGURE 1 is useful for obtaining a slow make and slow break mode of operation in both directions of the switch. This occurs when the equilibrium position of the mercury is varied by rotation of the switch so that a mercury head is produced. The mercury head forces the nonconductive fluid in the leg opposite from the leg with the mercury head through the frit 14 until the mercury levels are equalized.

In FIGURE 2, there is shown a switch 26 similar to the switch 10 described previously which utilizes air as the nonconductive fluid.

The switch 26 includes a V-shaped tube 28 having frits 30 and 32 at each end thereof. The frits 30 and 32 are similar to the time delay device 14 discussed previously. Additionally, contacts 34 and 36 are provided in each of the legs of the V-shaped tube 28 and are adapted to be bridged by mercury 38 having a mass just sufficient to bridge the contacts 34 and 36.

The switch in FIGURE 2 is also designed for slow make, slow break operation in both directions as air is forced out through one frit and is drawn in through the other frit when the head of the mercury has been varied. The V-shape insures that the leg in which mercury is moving downward is in a vertical position. The means for rotating the switch 26 has not been shown, it being understood that any suitable means for this purpose can be utilized. Similarly, the means for rotation has not been shown with respect to any of the switches disclosed as such means are considered conventional.

In FIGURE 3, there is shown a switch 40 built in accordance with the present invention which operates in a fast make, fast break mode with a snap breaking of contact in both directions.

The switch 40 comprises a pear-shaped tube 42 having a time delay device 44 at the top thereof. A pair of contacts 46 and 48 is provided adjacent the bottom of the pear-shaped tube 42 opposite from the time delay device 44 on opposite legs 47 and 49 respectively of the tube 42.

A first bypass tube 52 is provided having its lower end 54 below the contact 46 in the leg 47 and its upper end 56 adjacent the frit 44 in the leg 49. A second bypass tube 58 is provided having its lower end 60 below the contact 48 in the leg 49 and its upper end 62 adjacent the frit 44 in the leg 47.

The ends 54, 56 and 60, 62 of bypass tubes 52 and 58 respectively have only tiny apertures in communication with the legs 47 and 49. Thus, the bypass tubes 52 and 58 are additional time delay devices. However, the delay in the tubes 52 and 58 is substantially less than the delay of the frit 44. Thus, as the bypass tubes 52 and 58 are in parallel with the frit 44, the overall time delay of the switch 40 is substantially small.

The switch 40 in FIGURE 3 is shown in the off position. When the switch 40 is rotated counterclockwise so that the leg 49 is substantially vertical, the mercury 50 starts to move downward. The nonconductive fluid in the remainder of the tube 42 is metered through the bypass 52 and frit 44. This time delay is relatively fast. However, initially the nonconductive fluid does not pass through the bypass tube 58 as the mercury 50 seals off the lower end 60 of the bypass 58. When the mercury has moved downward sufficiently to uncover the end 60, the nonconductive fluid passes through the bypass tube 58 and there is a snap movement of the mercury 50 sufficient to insure fast breaking of the contacts 48 and 46. If the operation is reversed, the mercury 50 will quickly move toward contact 48, then slowly bridge the contacts as end 60 is covered. The mercury will not pass through the ends 54, 56, 60 and 62 as the holes therein are too small to allow passage of the mercury but are large enough to meter the nonconductive fluid therethrough. For example, these holes could be .001 to .003 inch in diameter. If desired, the bypass tubes 52 and 58 could have frits placed at the ends thereof to substitute for the small metering holes, or there could be scratches on the interior surface of the switch as shown in FIGURE 11.

In FIGURE 4, there is shown still another embodiment of the present invention in the form of a switch 64 which acts as a fast make, slow break switch with a snap off action when the circuit is actually opened.

The switch 64 consists of a pear-shaped tube 66 having a frit 68 dividing the tube into two legs 67 and 69. A contact 70 is provided in leg 67 similar to the contacts 16 and

18 of switch 10 discussed previously in that it provides 360° surface contact therefor. A second contact 72 is provided in a small mercury retention bubble 74 formed on the surface of leg 69 in communication with the leg. The bubble 74 insures that there will always be mercury to mercury contact with the contact 72. A bypass tube 76 is provided joining legs 69 and 67 about frit 68. The bypass tube 76 has a small metering hole 78 at the end joining leg 69 and a frit 80 at the end thereof joining leg 67.

A well 82 is provided in leg 67 by expanding the diameter of the leg 67 at a point above contact 70. The well 82 is useful in insuring that mercury 84 in the tube 66 will maintain a substantially constant level 86 in the well 82 during movement of the mercury in the leg 69. That is, the head 88 of the mercury in the leg 69 will move faster than the head 86 in the leg 67 due to the well 82.

The switch 64 has been shown in FIGURES 4 and 5. In FIGURE 4, the switch is in the on position, that is, the mercury 84 is bridging the contacts 70 and 72. To switch the mercury from the make or on position of FIGURE 4 to the break or off position of FIGURE 5, the tube 66 is rotated about its center of rotation so that leg 69 is vertical. When this rotation occurs, the level 88 is above the hole 78. Therefore, the nonconductive fluid in the tube 66 cannot pass through the bypass 76 as the mercury blocks the opening 78. Thus, the nonconductive fluid is metered through the frit 68 and the mercury 88 slowly ebbs downwardly. When the mercury passes the hole 78 in the bypass 76, an additional amount of nonconductive fluid can pass through the bypass 76 into the leg 69 above the mercury 84. This additional nonconductive fluid snaps the mercury 84 past the contact well 74 and the circuit is broken when the new level 88' of the mercury 84 is achieved in leg 69. It will be noted that a small amount of mercury 90 remains in the well 74 so that if the switch is rotated back to the position shown in FIGURE 4 wherein leg 67 is vertical, there will be immediate mercury to mercury contact and the switch will be turned on.

The switch 64 is especially useful for conditions wherein a switch must be turned on immediately but it is desirable to delay the shut-off for a certain period of time. For example, this type of switch is useful to control bedroom lights so as to give a person sufficient time to go to bed after turning off the switch before the lights go out.

In FIGURE 6, there is shown a means for varying the time delay of switches built in accordance with the principles of the present invention. That is, in FIGURE 6, the portion of the switch shown is designated by the numeral 92 and includes a tube 94 having a frit 96 in the center thereof. As stated previously, the time delay of the switches of the present invention depends upon the passage of nonconductive fluid through the frit. A strap and turn screw arrangement 98 is arranged immediately about the exterior of the tube 94 around the frit 96 so that by squeezing the frit 96 and tube 94, the passage of nonconductive fluid through the frit can be restricted and the time delay of the switch increased. By releasing the strap and turn screw 98, the time delay of the switch is decreased. This principle operates for resilient tubes and frits.

In FIGURE 7, a second means of varying the time delay is shown for a portion 100 of a switch including a tube 102 and a perforated plate 104. The perforated plate 104 is placed at an angle to the side walls of the tube 102 in a manner whereby a strap and clamp arrangement 106 can be utilized to vary the effective cross sectional area of the plate 104. By reducing the effective cross sectional area of the plate 104 in squeezing the tube 102, the strap and clamp arrangement 106 increases the time delay of the switch 100.

In FIGURE 8, there is shown a portion of a switch 108 built in accordance with the principles of the present invention. The switch 108 includes a tube 110 within which is a mass of mercury broken into two "slugs" 112

and 114 of mercury with a space 116 therebetween filled with the nonconductive fluid. The space 116 is sometimes called a bubble. In order to eliminate the bubble and thus provide circuit continuity between the slugs 112 and 114 of mercury and to mold them into a single mass, there is provided an anti-bubble device 118 in the form of a wire along the inner periphery of the tube 110. The wire 118 has a triangular cross section. The mercury cannot totally enclose the triangular wire but must leave an air passage along the length of the wire. Since the wire 118 has a length slightly less than the over-all length of the mercury but long enough to extend from the bubble 116 to a point outside of the end of slug 112, nonconductive fluid trapped in the bubble 116 will be forced out of the bubble by the head of slug 114 along the length of wire 118 to a point above slug 112. As an alternative, the wire 118 might be square-shaped or, as shown in FIGURE 10, could be two wires of circular cross section intertwined into a strand 120 forming an air passage along the length of the strand 120. In FIGURE 10, all of the elements of the switch 108 shown in FIGURE 8 which remain the same have been noted by primed numerals.

In FIGURE 11, still another method of eliminating the bubble 116 is shown. In FIGURE 11, switch 108' has a tube 110'' in one leg of which is formed a slug 112'' of mercury. In order to eliminate the bubble dividing the slugs of mercury, a groove 122 is scratched in the inner surface of the tube 110'' for a length corresponding to the length of the wire 118 in switch 108. The scratch groove 122 is small enough so that mercury cannot enter it.

A still further alternative for an anti-bubble device would be an extremely small tube having an inner diameter of .002 inch through which mercury could not flow.

Thus, the objects of the present invention have been achieved by utilizing a time delay device incorporated in a conductive liquid switch, which time delay device meters the nonconductive fluid therethrough to achieve control of the conductive liquid. The time delay device preferred for application in the switches disclosed in the present invention is a frit manufactured of a porous sintered disc which could be ceramic or metal. In ordinary pneumatic or hydraulic time delay switches, there is usually an external or separate time delay device which acts on the switch or contacts. In the time delay switch of the present invention, the switch itself is a time delay device. Therefore, there are no external moving parts which need be considered.

The switch of the present invention can be designed with any number of contacts in a multiplicity of arrangements. However, for purposes of simplicity, only switches having two contacts have been shown, it being understood that additional contacts could be added if desired.

The switch of the present invention can be manufactured of plastic, glass, or ceramic in accordance with the necessities of manufacture. The bypass tube associated with the main body of the switch provides the instant "on" or "off" features which are often desirable in a particular switch.

Further, by variation of the type of frit utilized, the size of bypass holes, and by the means illustrated in FIGURES 6 and 7, any time delay is possible. As can be seen from the drawings, the switch is capable of extreme miniaturization.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. An electrical switch comprising a symmetrical pear shaped annular hollow housing, said housing including two legs formed at an angle with respect to each other, a conductive liquid filling a portion of said housing and dividing the remainder of the interior of said housing into first and second spaced chambers on opposite sides of said

liquid, a non-conductive fluid in said chambers, a pair of spaced connectors in electrical conductive relation with the interior of said housing, each of said connectors being placed in a separate leg of said housing and equally spaced from the apex of said angle, said liquid being of sufficient volume to fill the space in said housing between said connectors, said chambers being in fluid communication, and time delay means for controlling fluid communication between said chambers.

2. The switch of claim 1 wherein said time delay means includes a foraminous disc forming an end wall of at least one of said chambers.

3. The switch of claim 1 wherein one of said connectors includes a flat metallic portion, said flat metallic portion being in electrically conductive relation with a portion of said connector exterior of said housing, said flat metallic portion conforming to the inner surface of said housing.

4. An electrical switch comprising a hollow housing, a conductive liquid filling a central portion of said housing and dividing the remainder of the interior of said housing into first and second spaced chambers on opposite sides of said liquid, a non-conductive fluid in said chambers, a pair of spaced connectors in electrical conductive relation with the interior of said housing, said liquid being of sufficient volume to fill the space in said housing between said connectors, said chambers being in fluid communication, time delay means for controlling fluid communication between said chambers, bypass means, said bypass means being operative to provide a second means of obtaining fluid communication between said first and second chambers, said bypass means including a second time delay means for controlling fluid communication between said first and second chambers.

5. The switch of claim 4 wherein said bypass means includes a fluid passageway, said fluid passageway having a constriction therein preventing the flow of conductive liquid therethrough.

6. An electrical switch comprising a hollow housing, a conductive liquid filling a central portion of said housing and dividing the remainder of the interior of said housing into first and second spaced chambers on opposite sides of said liquid, said housing including two legs formed at an angle, a non-conductive fluid in said chambers, a pair of spaced connectors in electrical conductive relation with the interior of said housing and equally spaced from the apex of said angle, said liquid being of sufficient volume to fill the space in said housing between said connectors, said chambers being in fluid communication, time delay means for controlling fluid communication between said chambers, an anti-bubble means, said anti-bubble means including a fluid passageway extending from said central portion to one of said chambers so that a bubble of fluid entrapped within said liquid may be released.

7. The switch of claim 6 wherein said anti-bubble means is a groove along the inner surface of said housing, said groove having a cross section small enough to prevent the flow of conductive liquid therein.

8. The switch of claim 6 wherein said anti-bubble means includes a longitudinally extending member in said housing extending between said central portion and said chamber, said longitudinally extending member providing a fluid passageway along the length thereof while immersed in said conductive liquid.

9. An electric switch comprising an annular hollow housing, a conductive liquid filling a portion of said housing, a foraminous disc located in the remaining portion of said housing, said foraminous disc dividing said remaining portion into two chambers on either side of said disc, a pair of spaced connectors in electrical conductive relation with the interior of said housing, said conductive liquid being of sufficient volume to fill the space in said housing between said connectors, a non-conductive fluid in said chambers, said foraminous disc being operative to control the rate of flow of said non-conductive fluid from

one of said chambers into the other of said chambers, a bypass, said bypass providing controlled fluid communication between said chambers, said bypass preventing the flow of conductive liquid therethrough, said bypass having at least one end thereof adjacent one of said connectors.

10. An electric switch comprising an annular hollow housing, a conductive liquid filling a portion of said housing, a foraminous disc located in the remaining portion of said housing, said foraminous disc dividing said remaining portion into two chambers on either side of said disc, a pair of spaced connectors in electrical conductive relation with the interior of said housing, said conductive liquid being of sufficient volume to fill the space in said housing between said connectors, a non-conductive fluid in said chambers, said foraminous disc being operative to control the rate of flow of said non-conductive fluid from one of said chambers into the other of said chambers, said annular hollow housing being flexible about said foraminous disc, clamping means for clamping said annular hollow housing and said foraminous disc therein to control the flow of non-conductive fluid through said disc.

11. An electrical switch comprising an annular hollow housing, a conductive liquid filling a portion of said housing, a foraminous disc located in the remaining portion of said housing, said foraminous disc dividing said remaining portion into two chambers on either side of said disc, a pair of spaced connectors in electrical conductive relation with the interior of said housing, said conductive liquid being of sufficient volume to fill the space in said

housing between said connectors, a non-conductive fluid in said chambers, said foraminous disc being operative to control the rate of flow of said non-conductive fluid from one of said chambers into the other of said chambers, a first bypass means extending from said second chamber into said portion adjacent the connector closest to said first chamber at a point between said connectors, and a second bypass means extending from said first chamber to said central portion adjacent the other connector closest to said second chamber at a point between said connectors, said bypass means being operative to allow the passage of said non-conductive fluid therethrough and to prevent the flow of conductive liquid therethrough.

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