March 14, 1967 P. E. MERRILL 3,309,481

THERMAL SWITCH WITH THERMALLY COLLAPSIBLE MEMBER

Filed March 4, 1965

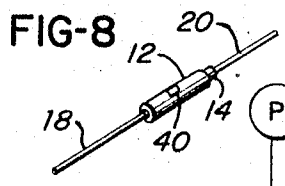


FIG-8

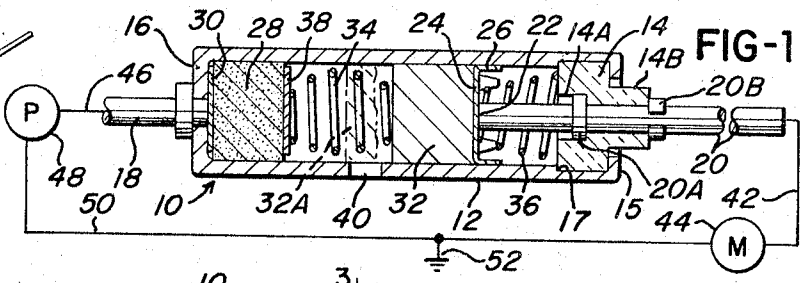


FIG-1

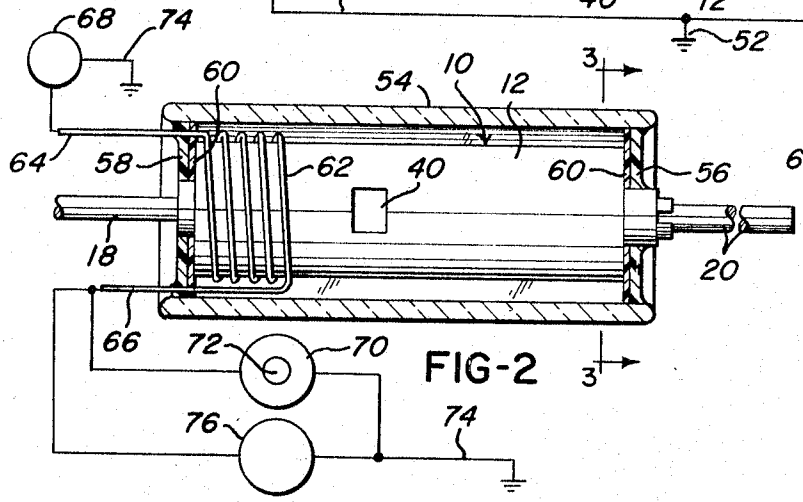


FIG-2

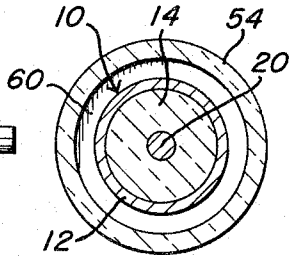


FIG-3

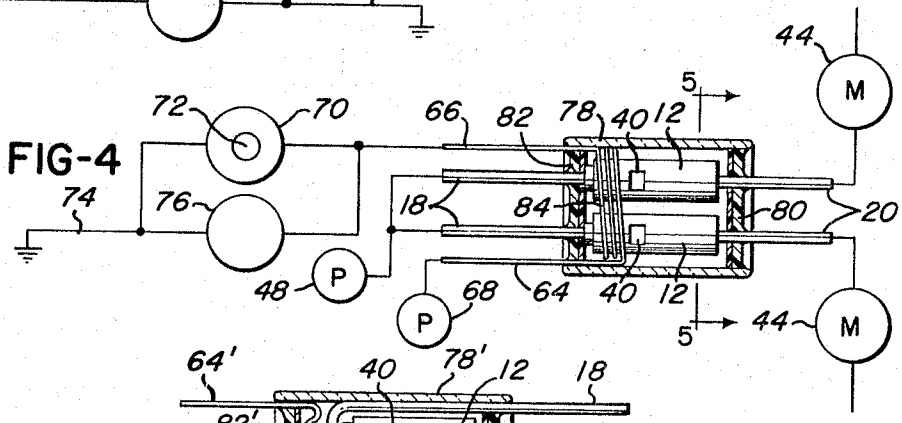


FIG-4

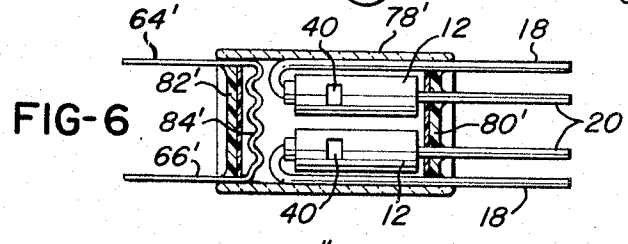


FIG-6

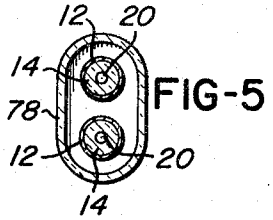


FIG-5

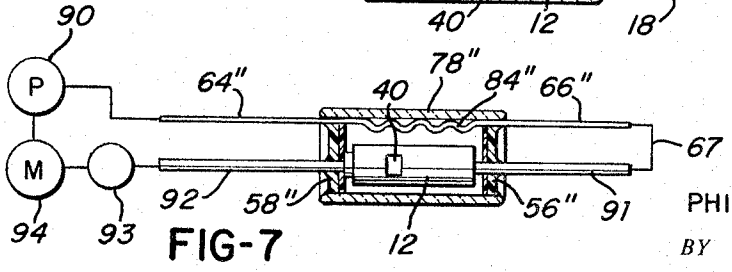


FIG-7

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THERMAL SWITCH WITH THERMALLY COLLAPSIBLE MEMBER

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2 Claims. (Cl. 200—142)

This invention relates to a thermal circuit breaker or switch.

Some of the features of this invention are disclosed in further detail in my application Ser. No. 197,213, filed May 4, 1962, as a continuation of my application Ser. No. 90,067, filed Feb. 17, 1961, and also as disclosed in my application Ser. No. 367,291, filed May 12, 1964, as a continuation-in-part of my said application Ser. No. 197,-213. Reference is made to such applications for further details, as may be required.

One of the features of this invention includes a circuit breaker or switch that has a metallic outer wall with an internal signal, the construction being such that the signal becomes visible when the circuit breaker or switch has blown, or its pellet has collapsed.

Another feature of this invention includes a thermally responsive circuit breaker, switch, or fuse, having a conductive cylindraceous wall such as disclosed in my said prior applications, and a surrounding insulative and/or transparent casing for protecting said conductive wall.

Another feature of this invention includes an external electric heater adjacent the collapsible pellet of the thermal circuit breaker or switch to cause the pellet to collapse by the heating action of the electric heater.

Another feature of this invention includes a thermally responsive circuit breaker, switch, or fuse that may be caused to blow manually or thermostatically or under the control of any other means.

Other features become apparent from this description, the appended claimed subject matter, and/or the accompanying drawings, in which:

FIGURE 1 is a diagrammatic cross section of a thermally responsive circuit breaker according to this invention.

FIGURE 2 is a cross section showing the thermally responsive circuit breaker, such as disclosed in my said prior applications, or as shown in FIGURE 1, encased in a transparent and/or insulative casing.

FIGURE 3 is a cross section along line 3—3 of FIGURE 2.

FIGURE 4 is a view showing a plurality of thermally responsive circuit breakers, such as disclosed in my said prior applications, or as shown in FIGURE 1, encased in a transparent or insulative casing, and also showing circuits connected thereto.

FIGURE 5 is a cross section along the line 5—5 of FIGURE 4.

FIGURE 6 shows a construction similar to that shown in FIGURE 4, but with the power and heating circuits connected in a different manner.

FIGURE 7 is a view showing a construction with a single thermally responsive circuit breaker or switch according to my said prior applications, or as shown in FIGURE 1, encased in a transparent and/or insulative casing, and with power and heating circuits connected slightly differently from FIGURE 2.

FIGURE 8 is a perspective view of the embodiment of FIG. 1 in substantially actual dimensions.

Certain words indicating direction, relative position, and the like, are used in this specification, and in the appended claimed subject matter, for the sake of clearness and brevity. However, it is to be understood that such words are used only for description in connection with the illustrations in the drawings, and that in actual use the parts so described may have entirely different directions, relative positions, etc., as is obvious.

A thermally responsive circuit breaker or switch **10**, according to this invention may have thermally responsive means within a casing **12**. Such casing **12** may be an electrically conductive casing, which may have an insulative end wall **14**, and an electrically conductive end wall **16**.

A first line conductor **18** may be connected to the conductive casing **12**, as by being connected to the conductive end wall **16** by a riveting or welding action. A second line conductor **20** may be insulatively mounted in the casing **12**, as by extending through the insulative or ceramic end wall **14** with a line contact at its end **22** in the casing **12**. The conductor **20** may be adhesively secured in the end wall as by epoxy resin adhesive, which may also form an adhesive coating between the flange **15** and the end wall **14**. The end wall **14** may be held between shoulder **17** and the flange **15**. The flange **15** may be pressed over the end wall **14** from its original straight condition, after the wall **14** with the conductor **20**, is inserted against the shoulder **17**.

A conductive disc **24** may have a resilient edge **26** contacting the interior of the casing **12**. This resilient edge **26** may take the form of resilient teeth, also marked **26**, integral with the body of the disc **24**. The teeth may be sufficiently outwardly biased, to maintain a good electrical contact with the interior of the conductive casing **12**. The central part of the disc **24** conductively engages the end **22** of the conductor **20**.

To insure good electrical conductivity, the conductors **18** and **20** may be silver plated, or may be solid silver, since the actual switch and conductors **18** and **20** are of very small size. Also, if desired, the interior of the casing **12**, and the disc **24** and its teeth **26** may be silver plated, or of solid silver.

If desired, the conductors **18** and **20**, the casing **12**, the disc **24** and its teeth **26** may be made of silver plated copper, solid silver, gold, or any other base metal or alloy with suitable conductivity and suitable minimum contact resistance characteristics to increase the conductivity between the contacting surfaces between such members, so that the current from one conducting member to another conducting member may have a minimum resistance imposed thereon.

A thermally collapsible pellet **28** may be placed adjacent the conductive end wall **16**, with a pressure absorbing and transferring disc **30** interposed between the end wall **16**, and the pellet **28**. The disc **30** may be metallic to conduct heat from the end wall **16** to the pellet **16**. However, if desired, the disc **30** may be omitted.

A cylindraceous spacing member or cylindrical plug **32** of substantial axial length may be placed adjacent the conductive disc **24**. A relatively strong coil spring **34**, under compressive load, may be placed outside the pellet **28**, with one end adjacent such pellet **28**, and with the other end pushing the spacer member **32**, to push the disc **24** against the line contact **22** while the pellet **28** is not collapsed.

A weak coil spring **36** under compression load may be provided between the disc **24** and insulative end wall **14**. Said weak coil spring **36** may surround the second line conductor **20** and may move the spacing member **32** with the disc **24** away from the line contact **22** when the pellet **28** is collapsed by thermal response to thermal conditions surrounding such pellet.

A pressure distributing disc **38** may be interposed between the spring **34** and the pellet **28**, to distribute the compression load or action of the spring **34** throughout the surface of the pellet **28**, to prevent local damage to the pellet **28**.

The thermally responsive switch 10 may be assembled by first attaching conductor 18 to end wall 16 and holding the casing 12 vertically with wall 16 downwardly. Then, in the order named, the following may be inserted in the casing 12 before the flange 15 has been inwardly pressed: disc 30, pellet 28, disc 38, spring 34, spacing member 32, disc 24, spring 36 and preassembled end wall and conductor 20. Then the flange 15 may be inwardly pressed. The wall 14 and conductor 20 may be preassembled by inserting the conductor 20 rightwardly into wall 14 with the integral flange 20A in the opening 14A. Then the wings 20B may be pinched outwardly to lock the conductor 20 against relative longitudinal movement with respect to the wall 14. The wall 14 is provided with a smaller diameter extension 14B to extend the dielectric span between the flange 15 and the conductor 20. The spacing member 32 may form a signal to show whether the pellet 28 is collapsed, or not collapsed. For this purpose, the member 32 may be made so that it is readily visible and distinguishable. For example, it may be painted a distinctive color, such as red or the like.

A viewing means, such as window or hole 40, may be provided in the casing 12. Such viewing means 40 may be of limited size, to permit viewing of the spacing member differently when the pellet is collapsed as compared to when it is not collapsed. For example, it may be so placed in the casing 12, and may be made of such size that the spacing member 32 cannot be seen when the pellet 28 is not collapsed, such as when the member 32 is in the position shown in FIGURE 1. In that position, the member 32 cannot readily be seen through the window 40. However, when the pellet 28 collapses in response to high temperatures, the member 32 is moved leftwardly in FIGURE 1 to the dotted line position 32A, so that it is visible in the window 40. It may be made more visible if the member 32 is distinctively colored, such as in red.

The reason that the member 32 moves leftwardly is that when the pellet 28 collapses the disc 38 yields leftwardly and the spring 34 elongates. The member 32, and the disc 24 are then moved leftwardly by the coil spring 36, which then has sufficient compressive strength to overcome the lost compressive strength of the spring 34. The spring 34 loses its compressive strength by being elongated, when its left end is allowed to move leftwardly because of the collapse of the pellet 28.

When the pellet 28 collapses, the electrical conductivity between the conductors 18 and 20 is broken by the separation of the disc 22 from the contact 22 when the disc 24 is moved leftwardly away from the contact 22 by the spring 36. The spring 36 is made conical in shape, with its right hand coils so large that the spring 36 cannot come into contact with the conductor 20 when the pellet collapses.

The size of the thermal circuit breaker of this invention is relatively small, and FIGURE 8 shows substantially the actual size of the circuit breaker, as it is shown in the original drawings of this application. For example, outer dameter of the casing 12 may be ⅛" or less and the length of the casing 12 may be as proportionally illustrated in comparison to such diameter of casing 12.

It is therefore to be seen that the switch 10 is a thermally responsive switch having means for changing the power circuit passing through the switch in response to a thermal change that can collapse the pellet 28. Also, the casing 12 has a visible signal, such as is produced by the spacing member 32 in combination with the opening 40, so that the spacing member 32 is visible to show that the switch has changed the circuit.

Collapsible pellets of the character used in connection with this invention are, per se, manufactured and on sale in the United States, and are available to persons skilled in the art to which this invention pertains. The particular composition of such collapsible pellets is not the

subject of this invention. Such compositions are well known to the manufacturers of such pellets. Some patents relating to thermal fuses disclose compositions which are collapsible within a narrow range of a high temperature, and which remain substantially in solid condition until such temperature is reached. It is therefore believed unnecessary to disclose, in this application, any of such well known compositions of such collapsible pellets.

The switch 10 of FIGURE 1 may be used to control a power circuit. For example, the conductor 20 may be connected by the power line line 42 with the motor or other power consuming device 44. The other conductor 18, may be conected by the power line 46 with a source of power P. The circuit may be completed, by connecting the source of power 48 with the motor 44 through a power conductor 50, which may be grounded, if desired, at 52.

The switch 10 of FIGURE 1 may be encased in a transparent, or insulative, casing 54, if desired. The casing 54 may be a cylindrical or cylindraceous casing having insulative ends 56 and 58, through which the conductors 20 and 18 may pass. The end walls 56 and 58 may be made of any desired insulative material, such as plastic material. A plastic disc 60 may be provided on which epoxy adhesive or other resinous material may be placed to produce insulative walls at 56 and 58. If desired, insulative board or paper-like material may be used, which is sufficiently strong to maintain the conductive casing 12 stationary within the casing 54.

If desired, the casing 54 may be made of glass, such as a relatively thermo-resisting glass, such as is ordinarily called "Pyrex glass." The composition of such glass forms no part of this invention. It is available and on sale throughout the United States.

Electrical heating means, such as an electrical heating coil 62 may be placed in the casing 54 in such a manner that, when the coil is heated, or has been heated for a certain length of time, the pellet 28 is caused to collapse and change the power circuit passing through the casing 12 either to make, or to break the power circuit, as desired. If the switch is of the character shown in FIGURE 1, the spacing member 32 of FIGURE 1 will become visible at the window 40, when the pellet 28 collapses, and it will be also visible through the glass cylindrical wall 54. If desired, the electrical heater 62 may be connected to heating conducting means, such as wires 64 and 66. The wires 64 and 66 may pass through either or both end walls 56 or 58. They are shown as passing through the wall 58 in FIGURE 2.

The heater 62 may be connected to a source of power 68. The source 68 may be the same source as 48 of FIGURE 1, or it may be a different source of power, and of different voltage if desired.

The electrical heater 62 may be controlled by a manual switch 70, which may have a push button 72 or the like to complete a circuit from the source of power 68, to the grounded line 74, for example.

If desired, the heater 62 may be alternatively or additionally controlled by a thermally responsive switch 76 which, for example, may be thermally responsive to the temperature of the motor 44 of FIGURE 1, or to any part thereof, so that the switch 76 closes when the motor 44 becomes overheated to cause the pellet 28 of FIGURE 1 to collapse and open the power circuit to the motor 44. The switch 76 is shown as being in parallel with the manual switch 70, although, if desired, the control switches 70 and 76 may be provided in series for controlling the heater 62, if desired.

The thermal switch 12 in the casing 54 may be used to protect the starting circuit of the motor 44. For example, the line 66 may be placed in series or in parallel with the starting winding of the motor 44, and the responsiveness of the pellet 28 may be selected so that if the heater 62 is energized for a length of time longer than

is safe for the starting winding to be energized, then the pellet **28** will collapse, and protect the motor.

FIGURE 4 shows a construction in which two switches, each with a casing **12**, may be placed in a transparent and/or insulative casing **78**, which may be cylindrical, or cylindraceous. It may have a transverse cross section as shown in FIGURE 5. The end walls **80** and **82** may close the ends of the casing **78**, and the walls **80** and **82** may be insulative in character, and substantially identical in construction with the end walls **56**, **58** and **60** of FIGURE 2. An electrical heater **84** may be placed in the casing **78**, so that it is effective to collapse the respective pellets **28** in the casings **12** of the two thermal switches. While only one heater is shown as coiled around both casings **12**, it is understood that separate heaters may be provided for the two switch casings, as is obvious, with each heater surrounding its respective casing **12**. The power conductors **18** and **20** of the switches may pass through the end walls **80** or **82**. The conductors **20** may be respectively connected to separate motors **44** or other power consuming devices, and the conductors **18** may be connected to a source of power **48**, or to different sources of power, if desired. The line **66** from the heater **84** may be connected to the manually actuatable switch **70**, and/or to a thermostatic switch or the like **76**, in a manner similar to that previously described in connection with FIGURE 2.

FIGURE 6 shows a construction somewhat similar to that shown in FIGURE 4. However, the cylindrical or cylindraceous casing **78'**, which may have a cross section similar to that shown in FIGURE 5, has the power lines or conductors **20** and **18** passing through the end wall **80'**, and the electric heater conductor lines **64'** and **66'** passing through the end wall **82'**. The electric heater **84'** is shown of slightly different shape, and is placed at the end of the casing, instead of surrounding the conductive casings **12**.

In FIGURES 4, 5 and 6, two or more switches **12** may be placed in the casings **78** and/or **78'**. The cross sections of the casings **78** and/or **78'** may be varied to accommodate the various numbers of switches **12** that are placed in them. For example, their cross section may be circular instead of oblong, if desired.

The switches **12** in FIGURES 2–7 may be used without the windows **40** if visual signal is not desired. The casings **54**, **78**, **78'** and **78''** may be made of opaque insulative material when no visual signal is desired.

FIGURE 7 shows a construction somewhat similar to that of FIGURE 2, except that the electric heater lines **64''** and **66''** pass through the end walls **56''** and **58''** of casing **78''** instead of through one end wall, as shown in FIGURE 2.

In FIGURE 7, as well as in any of the other embodiments, the construction may be made as a "slow blow fuse" or overcurrent circuit breaker. In FIGURE 7, for example, a source of power **90** may be connected to the line **64''** so that current passes through heater **84''**, line **66''**, connector **67**, line **91**, switch **12**, line **92**, controller or manual switch **93**, motor **94** and back to source of power **90**. If desired, the lines **66'**, **67** and **91** may be inside the casing **78''** and need not pass through wall **56''**. The heating capacity of the heater **84''** may be regulated by choice of length and/or resistance of heater **84''** so that the switch **12** will not be heated enough to blow and open the circuit during a short safe start or safe overload of motor **90**, but will heat enough to blow and open the circuit if the starting period is unsafely long or if there is an unsafely long overload.

It is thus to be seen that a switch construction has been provided which can be used as a "slow blow fuse," such as to protect an unduly long and unsafe period of overload, high temperature, and the like, after which the pellet **28** collapses. The thermal environment that collapses the pellet **28** under these conditions may come from the environment surrounding the casing **12**. The

fuse can also be used as a "current vs. time circuit breaker," such as described in connection with the starting winding of the motor. The controller may be made to have the pellet collapse due to the ambient temperature surrounding the casing **12**. The controller may be used to have a signal, such as at the window **40**, but such window **40** may be omitted when visual signal is not desired.

It is also to be understood that the outer casing **54** need not be transparent, and may be insulative and opaque, such as of ceramic material and the like, if desired. Also, the controller of FIGURE 1 may be used without the outer casing **54** under certain conditions, and the window **40** may be protected by a transparent member locally applied to the window **40**.

While the form of the invention now preferred has been disclosed as required by the statutes, other forms may be used, all coming within the scope of the claims which follow.

What is claimed is:

1. A switch comprising: a cylindrical electrically conductive casing with an electrically conductive end wall and an insulative end wall; a first line conductor connected to said conductive end wall; a second line conductor extending through said insulative end wall with a line contact in said casing; a conductive disc having an edge contacting the interior of said casing; a thermally collapsible pellet adjacent said conductive end wall; a cylindraceous spacing member of substantial axial length adjacent said conductive disc; a thermally collapsible pellet adjacent said conductive end wall; a strong spring outside said pellet with one end adjacent said pellet and with the other end pushing said spacing member to push said disc against said line contact while said pellet is not collapsed; a weak coil spring surrounding said second line conductor and moving said spacing member with said disc away from said line contact when said pellet is collapsed, said conductive casing having a viewing means of limited size to permit different viewing of said spacing member when said pellet is collapsed and is not collapsed and in which a cylindraceous insulative casing surrounds said conductive casing and in which said first and second line conductors extend endwise out of said insulative casing and in which said insulative casing contains electrical heating means effective on said pellet; and electrical connecting means extending endwise out of said insulative casing and being connected to said heating means.

2. A switch comprising: a cylindrical electrically conductive casing with an electrically conductive end wall and an insulative end wall; a first line conductor connected to said conductive end wall; a second line conductor extending through said insulative end wall with a line contact in said casing; a conductive disc having an edge contacting the interior of said casing; a thermally collapsible pellet adjacent said conductive end wall; a cylindraceous spacing member of substantial axial length adjacent said conductive disc; a thermally collapsible pellet adjacent said conductive end wall; a strong spring outside said pellet with one end adjacent said pellet and with the other end pushing said spacing member to push said disc against said line contact while said pellet is not collapsed; a weak coil spring surrounding said second line conductor and moving said spacing member with said disc away from said line contact when said pellet is collapsed, said conductive casing having a viewing means of limited size to permit different viewing of said spacing member when said pellet is collapsed and is not collapsed; a second switch identical to said first named switch; said two switches being in parallel relationship in which a cylindraceous insulative casing surrounds the conductive casings of said switches and in which said first and second line conductors of said switches extend endwise out of said insulative casing and in which said insulative casing contains electrical heating means effec-

tive on said pellets of said switches; and electrical connecting means extending endwise out of said insulative casing and being connected to said heating means.

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