April 27, 1965 P. E. MERRILL 3,180,958
THERMAL SWITCH HAVING TEMPERATURE SENSITIVE
PELLET AND SLIDING DISC CONTACT
Filed May 4, 1962 2 Sheets-Sheet 1

FIG. 1

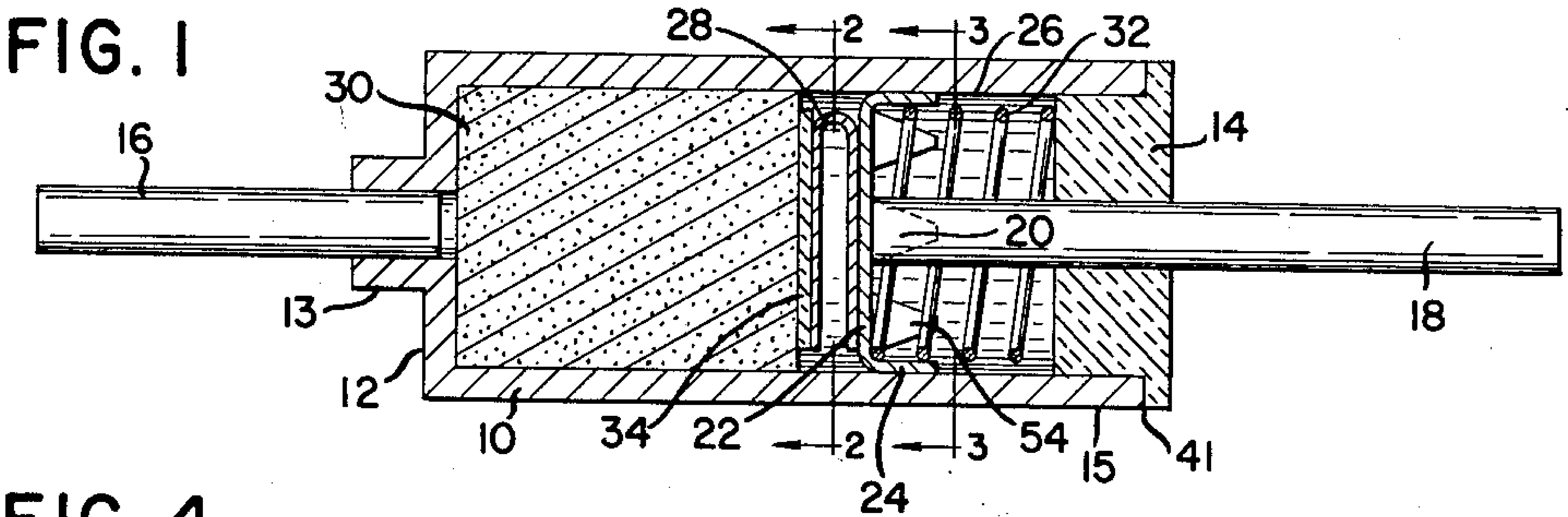


FIG. 4

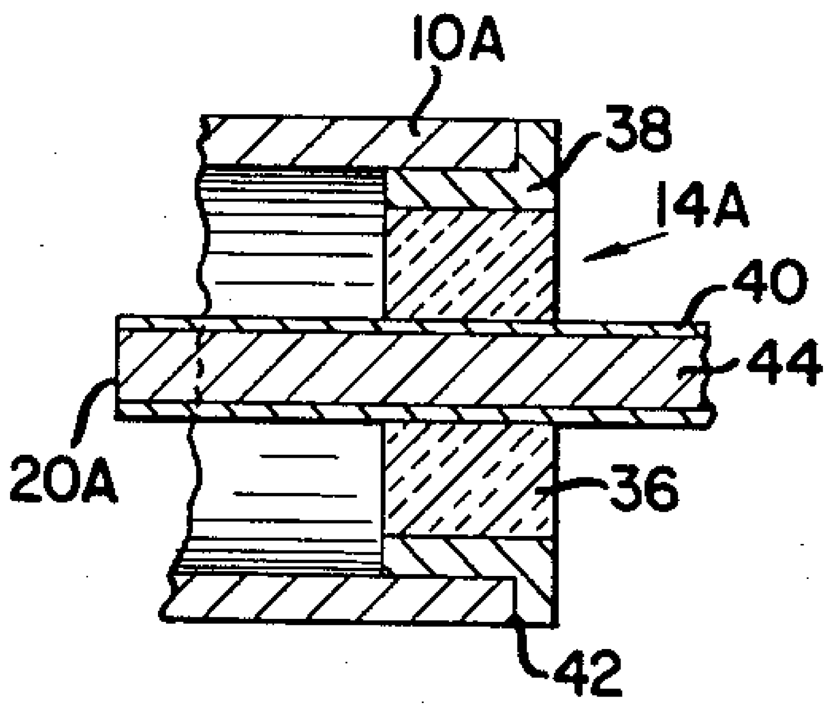


FIG. 2

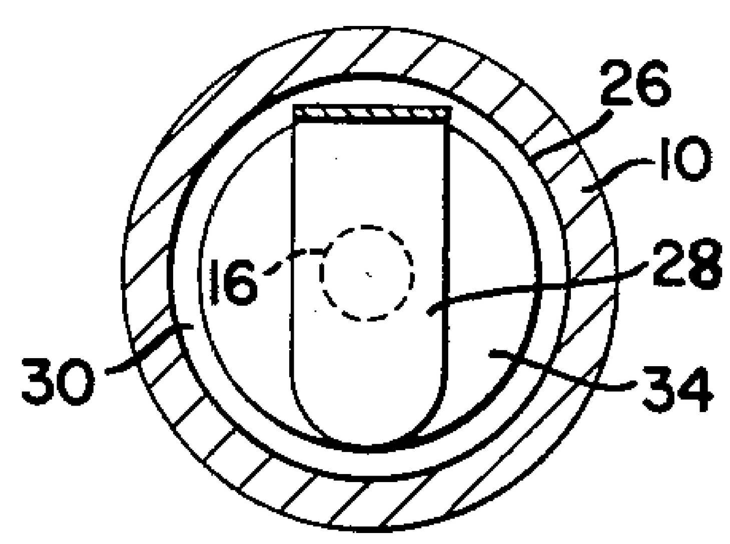


FIG. 3

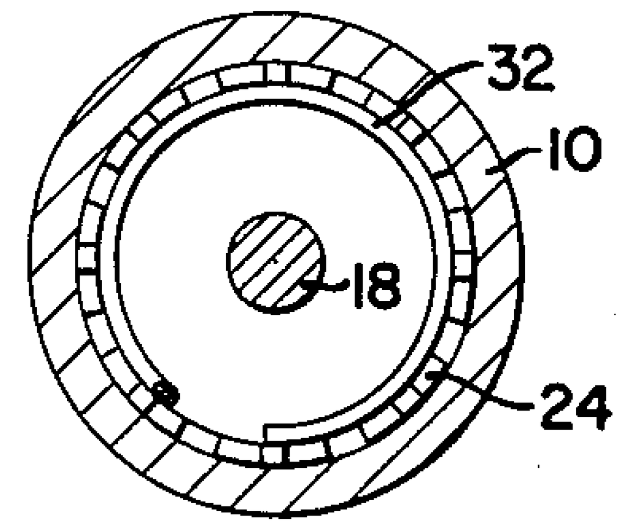


FIG. 5

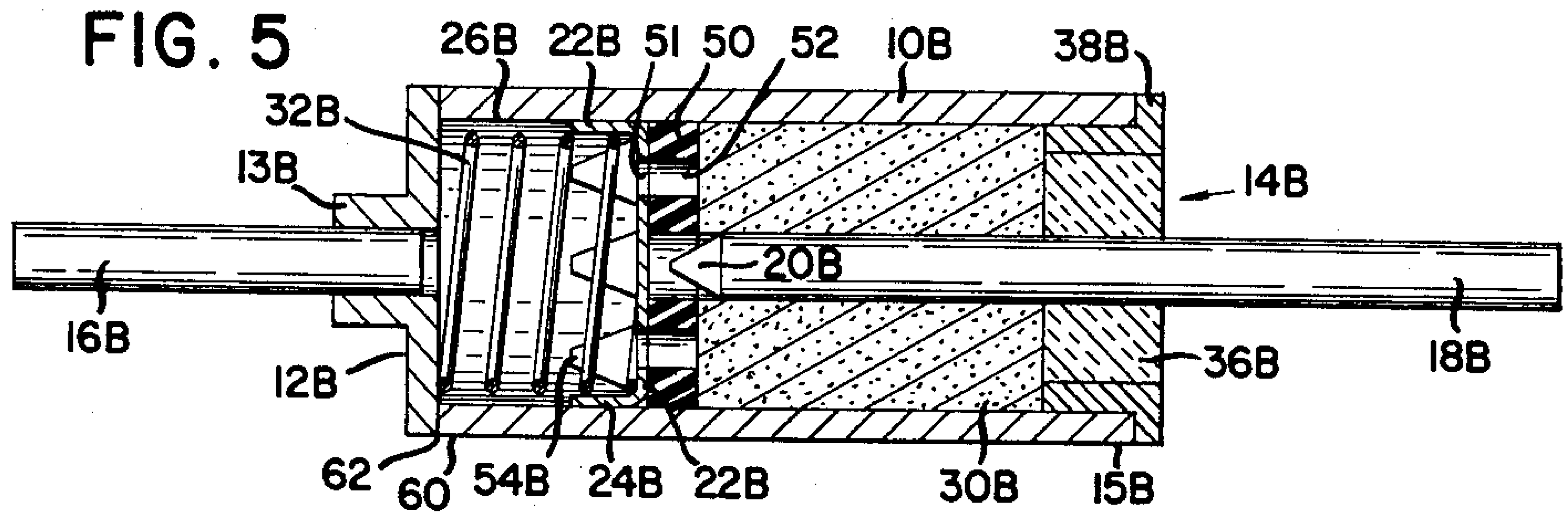


FIG. 6

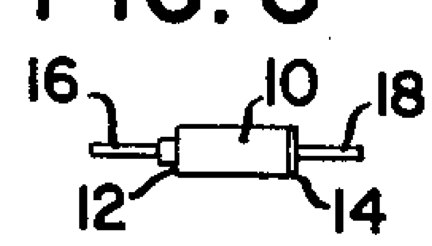
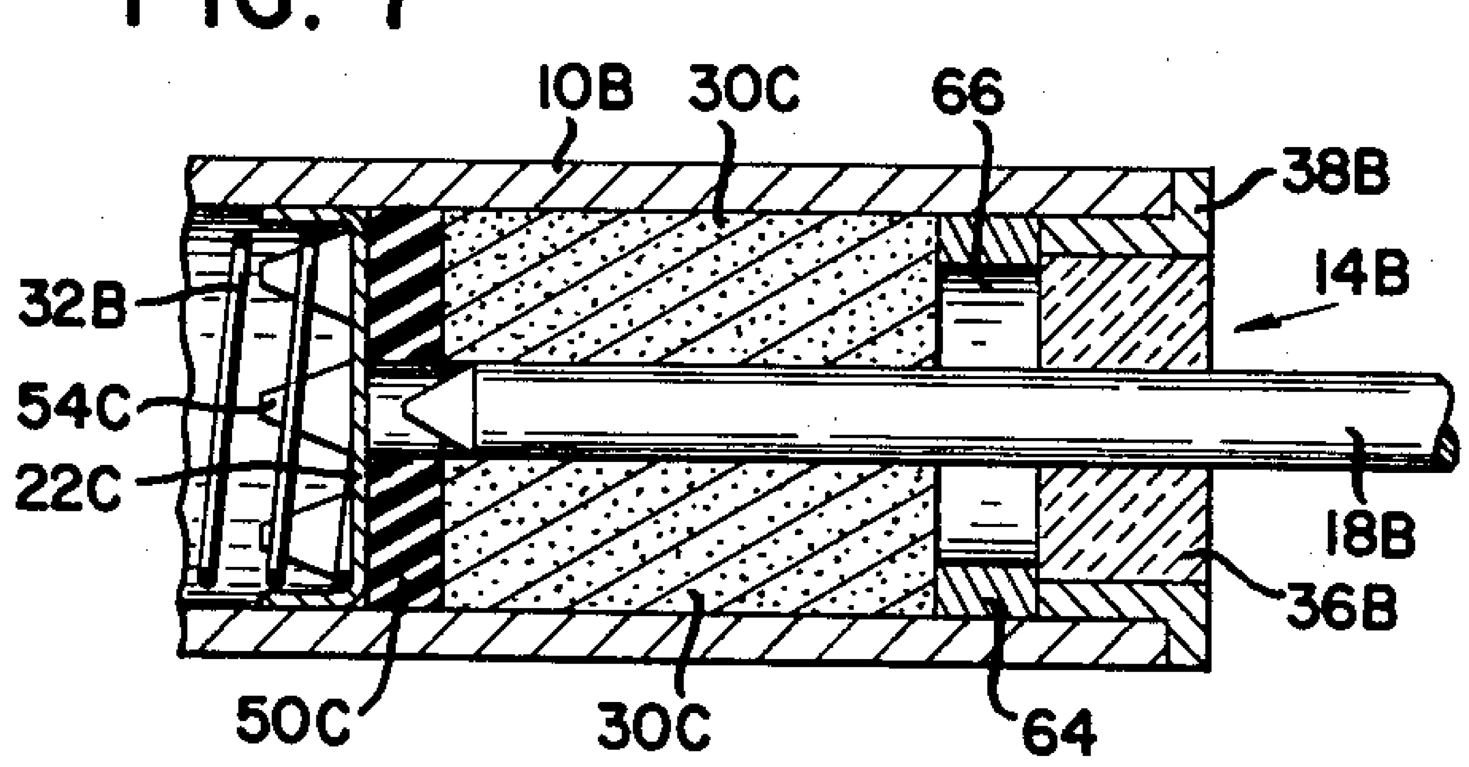


FIG. 7



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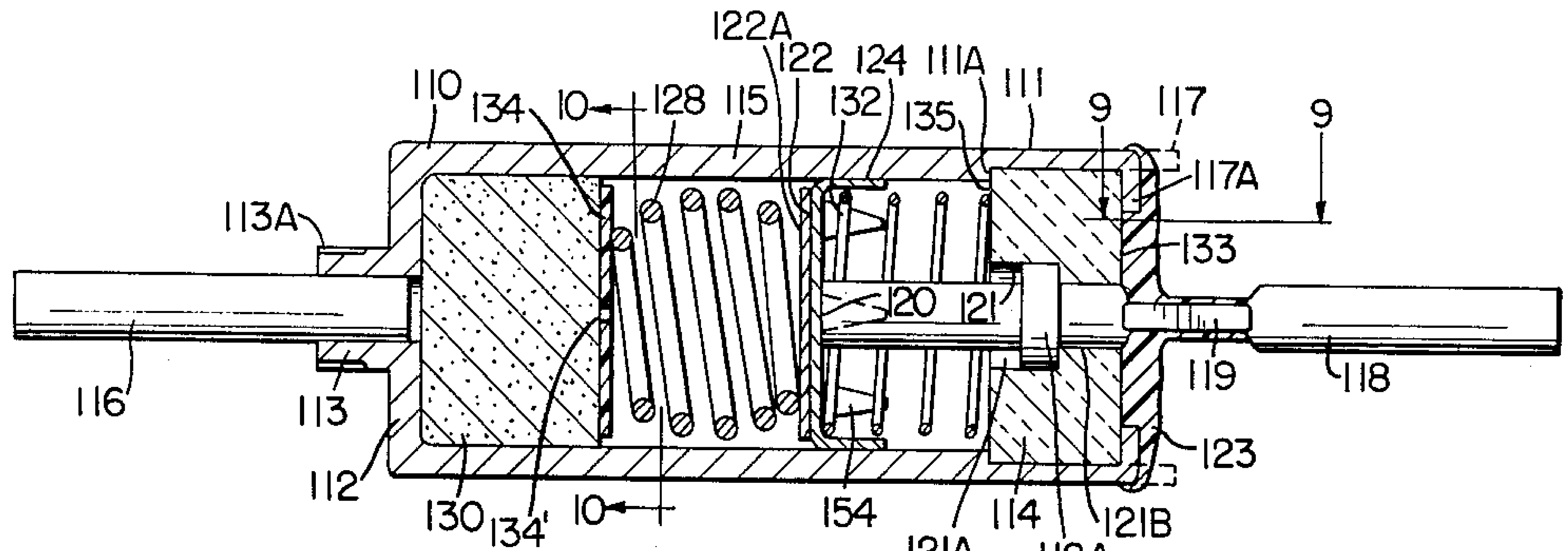

FIG-8

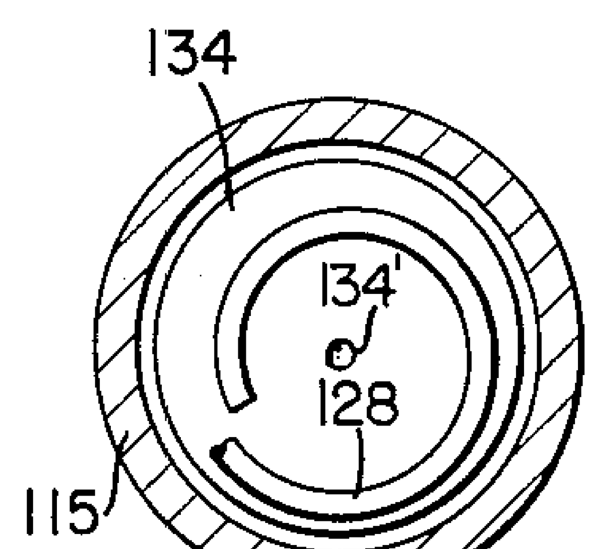

FIG-10

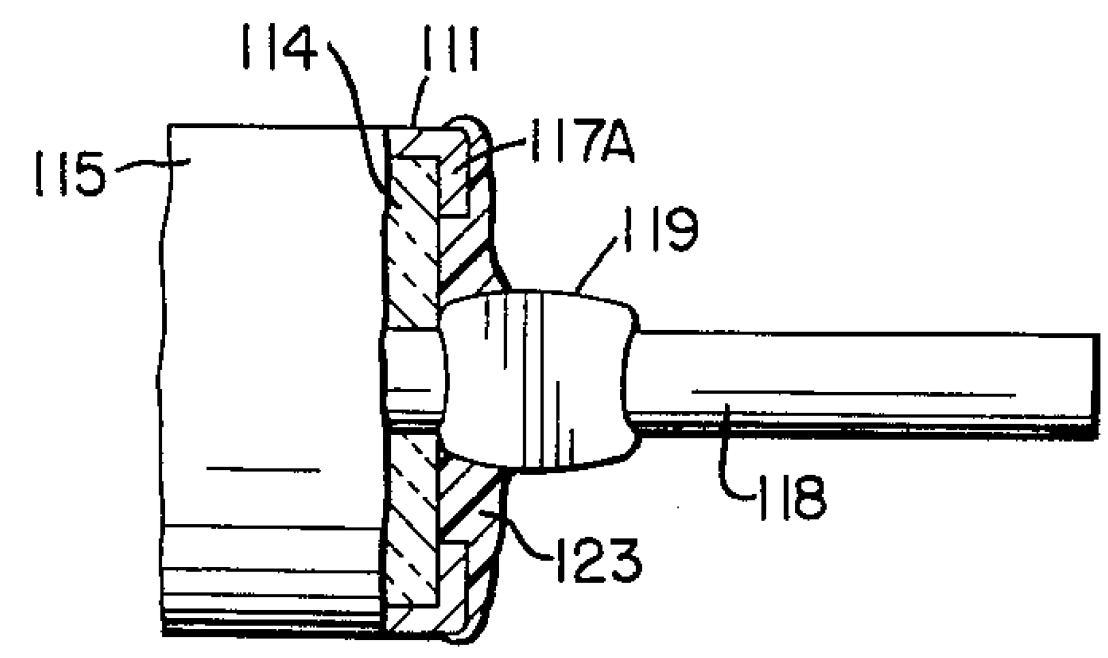

FIG-9

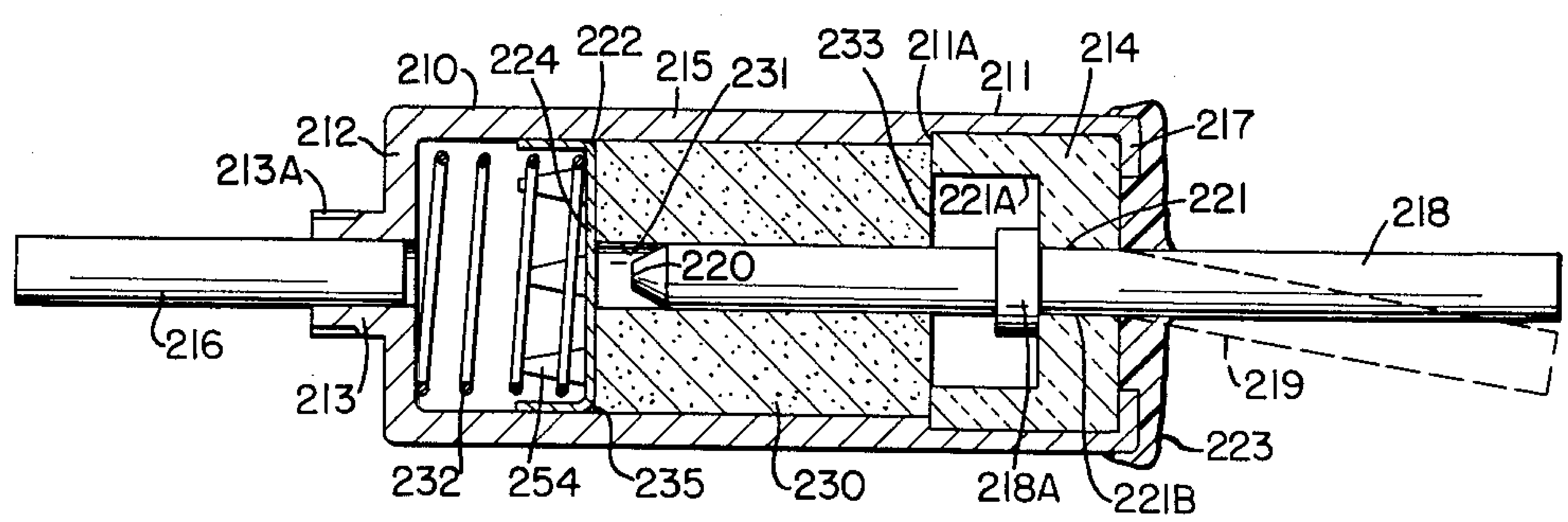

FIG-11

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THERMAL SWITCH HAVING TEMPERATURE SENSITIVE PELLET AND SLIDING DISC CONTACT

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Filed May 4, 1962, Ser. No. 197,213
20 Claims. (Cl. 200—142)

This invention relates to a switch and particularly to a small or minute switch of the permanent make-or-break type. The switch is of very high amperage capacity, notwithstanding its minute size.

The arrangement of the parts of this switch is such that it has negligible internal resistance to the flow of the rated current through the switch which is much less than the internal resistance of previous switches. The parts lend themselves to efficient methods of production. For example, many of the parts may be of a cylindrical or circular construction which may be made by efficient tools. The parts also lend themselves to quick and accurate assembly, notwithstanding the small size of the switch.

The switch of this invention has a faster response to ambient temperatures because the body of the switch is made of a material with high thermal conductivity, which permits faster conduction of ambient temperature or heat to a sensitive, destructible pellet or the like.

This switch is of relatively smaller size for a specified ampere rating, as compared to other switches of this character.

A switch according to this invention is also smaller in size for any specified dielectric or voltage breakdown capacity.

The opening, or closing, or other operative action dependent on temperature is less affected by the amount of current flowing through the switch, such as from "'0" amperes to the rated ampere capacity of the switch.

The switch is less expensive to produce in quantity and the design lends itself to simplified automatic production.

The switch is so constructed that it is almost impossible for it to fail to operate, and, hence, it is more reliable.

The switch is less subject to changing characteristics with exposure to age and environment below the expected operating temperature than other similar switches.

The switch is more accurate, since it is dependent only on the temperature breakdown characteristics of the permanently collapsible pellet or the like when used within the rated current. Any heat that may be generated by the flow of current through the switch does not materially affect the action of the pellet, when the switch is used within its current rating.

The switch uses a sliding contact, sliding against the interior of the casing, which is held against movement into or out of contact with a line conductor by a temperature sensitive melt or crumble pellet and by a spring construction cooperating with said pellet to move the sliding contact upon collapse of the pellet.

The switch uses a casing which may be tubular or cylindrical for enclosing the working parts of the switch, and this casing is also used as a conductor for the current and/or the transmission of ambient temperature. This provides a high electric conductivity and thermal conductivity to the switch.

The switch uses a simple insulative end wall with a line conductor passing through such wall to produce a thermal responsive fuse construction.

Accordingly, it is an object of this invention to provide a switch having one or more of the features herein disclosed.

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Other objects become apparent from this description and/or the accompanying drawings, in which:

FIGURE 1 is a longitudinal cross section of an embodiment of this invention.

FIGURE 2 is a transverse cross section along the line 2—2 of FIGURE 1.

FIGURE 3 is a transverse cross section along the line 3—3 of FIGURE 1.

FIGURE 4 is a longitudinal cross section of an insulative wall at the end of another embodiment of this invention.

FIGURE 5 is a longitudinal cross section of another embodiment of this invention.

FIGURE 6 is a side elevation shown substantially in actual size scale on the drawings of this switch with a 15 ampere rating and with a transient overload rating of at least 60 amperes for 3 seconds.

FIGURE 7 is a cross section of a portion of another embodiment of this invention.

FIGURE 8 is a longitudinal cross section of another embodiment of this invention.

FIGURE 9 is a partial cross section taken along the line 9—9 of FIGURE 8.

FIGURE 10 is a transverse cross section taken along the line 10—10 of FIGURE 8.

FIGURE 11 is a longitudinal cross section of another embodiment of this invention.

FIGURES 1, 2 and 3 show a normally closed embodiment of the switch. It has an electrically and thermally conductive casing **10**. The casing **10** may be of any desired shape, such as tubular or cylindrical and having a conductive end wall **12** with a flange **13** at one end and an insulative end wall **14** at the other end **15** of casing **10**. A first line conductor **16** may be electrically connected with the casing **10**, such as at the conductive end wall **12**, by insertion and securing in flange **13**. A second line conductor **18** extends into the casing, such as through the insulative end wall **14** with a contact, such as at its conductor end **20**, extending into the casing **10**. A movable electrically conductive contactor, such as disc **22**, is provided in the casing **10** with its edge **24** electrically contacting the interior surface **26** of the casing **10** and movable axially to two positions. These two positions respectively are in contact with the said conductor contact or end **20**, as in FIGURE 1, and out of contact with said conductor contact or end **20**. This last position is produced by leftward movement of the disc **22** in FIGURE 1, or is an initial position in FIGURE 5. A relatively strong spring **28** and a permanently thermally collapsible pellet **30** are located in the casing **10** adjacent the conductive end wall **12**. The strong spring **28** and pellet **30** cooperate to maintain the disc **22** in contact with the conductor contact or end **20** while the pellet **30** is not collapsed. As shown in FIGURE 1, the pellet **30** is adjacent the end wall **12**. A weaker spring **32** moves the disc **22** out of contact with the conductor contact or end **20** upon collapse of the pellet **30**.

If desired, a sheet insulator **34** may be placed between the spring **28** and the pellet **30** to insulate the pellet **30** from any heat that may be generated by the flow of electric current from the line conductor **18** at its end **20** into the disc **22**. The insulator **34** also distributes stresses transmitted from the spring **28** to the pellet **30**. If desired, the insulator **34** may be circular in shape, and smaller in diameter than pellet **30**, as shown in FIGURE 2.

FIGURE 4 shows another embodiment of this invention. An alternate insulative end wall is shown and is designated by the numeral **14A**. It may be used in higher temperature applications, and also where a better hermetic sealing property is desired. For example, the end wall core **36** may be composed of glass which is fused to a metal ring 38 and to the outer cylinder 40 of the line conductor. The ring 38 can then be sealed with high temperature adhesive, or may be soldered, brazed, or welded to the casing 10A which corresponds to the casing 10 of FIGURE 1. This sealing may be accomplished along a seam 42. The cylinder 40 may contain a copper core 44 to improve electrical conductivity.

All the members of the switches of this invention which have contact surfaces through which current passes may be covered with a thin silver coating at such contact surfaces to increase the conductivity through the switch. Silver to silver contact increases the contact conductivity very much. If desired, the members which are silver coated at the contact surfaces, may also be silver coated throughout all of the surfaces, as it is generally just as economical to coat the entire surface with a thin coat of silver as it is to coat a limited surface. This is particularly true in a minute size switch of the character herein disclosed. For example, the casing 10, 10A or 10B, the contactor 22 or 22B, the line conductor 18 and 18B, may all be silver plated. Also the end 20A, FIGURE 4, of the cylinder 40 and the conductor 44 may be silver plated, and the entire surfaces of sleeve 40 and the end surfaces of conductor 44 may be so coated.

In any of the switches, the line conductor 16 and 16B, may be made of copper, to improve electrical conductivity. The casing 10 may be made of brass to improve electrical conductivity, and may be silver plated as previously stated. The brass of casing 10 also increases the thermal conductivity and the strength and machinability of the casing 10.

The spring 28 may be made of stainless steel or other material to improve strength at elevated temperatures.

The conductor disc 22 can be made of copper to improve electrical conductivity. The spring 32 may be made of stainless steel or of other materials as described in connection with spring 82. The insulative wall 14 can be any non-electrical conductive material which has the necessary strength characteristics at the temperatures substantially above the expected operating temperatures. The material of wall 14 may be, for example, phenolic or epoxy plastic materials.

The conductor 18 and 18B can be made of copper to improve electrical conduction. The ring 38 can be made of low carbon steel, Monel metal, stainless steel, nickel-iron alloy, etc. The insulating material 36 of FIGURE 4 may be high melting temperature insulating material such as glass, Pyrex, etc. The sleeve 40 may be of the same material as ring 38. The core 44 in sleeve 40 may be made of copper.

FIGURE 5 shows a switch which is normally open, but closes in response to high ambient temperature. This type of switch may be used as a fire alarm or fire extinguishing control, for example. An electrically and thermally conducting cylinder 10B has a conducting end wall 12B and an insulative wall 14B. A line conductor 16B is electrically connected to the casing of the switch, such as at the wall 12B. The conductive wall 12B may or may not be a disc separate from casing 10B, and, if separate, it is conductively secured to the casing 10B by soldering or the like. The second line conductor 18B extends through the insulative wall 14B with a contact such as its conductor end 20B extending into the casing 10B. A movable electrically conductive disc contactor 22B is placed in the casing 10B with its edge 24B electrically contacting the interior 26B of the casing 10B. The movable disc contactor 22 is movable axially to two positions. These positions are, respectively, in contact with the conductor contact or end 20B, and out of contact with the conductor contact or end 20B. A spring 32B and a permanently thermally collapsible pellet 30B in the casing 10B cooperate to maintain the disc 22B out of contact with the conductor end 20B while the pellet 30 is not collapsed. A spacer 50 is interposed between the disc 22B and the pellet 30, to maintain the disc 22B out of contact with the contact or end 20B, as long as the pellet 30B is not collapsed. However, when the pellet 30B collapses, because of a high temperature surrounding, or adjacent to, the switch, then the pellet 30B melts or crumbles with or without decrease in volume. If there is no decrease in volume, then fluid escape means, such as passageways 52, may be provided to receive some of the fluid material of pellet 30B when the pellet collapses. This permits the separator 50 to be pushed by the spring 32B, through the medium of disc 22B rightward in FIGURE 5, so that the contactor 22B then engages the contact or end 20B of the line conductor 18B. When this is done, then the previously open circuit is closed, the current flowing between line conductor 16B, through end wall 12B, casing 10B, disc 22B, and contact or end 20B to the line conductor 18B. If desired, openings 51 in the disc 22B may be provided which are aligned with openings 52 in the separator 50.

If desired, the separator 50 may be made of insulating material. Also, if desired, the insulative wall 14B may include a ring 38B and an insulating core 36B which may be identical in construction with members 36 and 38 in FIGURE 4, but with the capital letter B omitted.

FIGURE 7 shows an embodiment somewhat similar to that shown in FIGURE 5. All parts which are substantially identical to FIGURE 5 are shown with the same reference numerals. The omitted parts are identical to those shown in FIGURE 5 such as line conductor 16B, end wall 12B, seam 62 and the remainder of spring 32B.

However, in FIGURE 7 the movable disc contactor 22C has no holes 51. The movable spacer 50C has no holes 52. The pellet 30C is slightly shorter than pellet 30B. The right end of pellet 30C engages the ring 64 which surrounds the cavity 66. The ring 64 has a loose fit in casing 10B for assembly purposes.

The cavity 66 provides space for the flow or travel of a portion of pellet 30C when the pellet collapses. This permits the spacer 50C and sliding disc contactor 22C to move rightward by the force of the spring 32B with the disc contactor 22C engaging the line conductor 18B to close the circuit when the pellet 30C collapses.

Otherwise the switch of FIGURE 7 is substantially the same as the switch of FIGURE 5.

Wherever capital letters have been added after a reference numeral, it is intended to indicate that, in general, the member having a capital letter is identical with or similar to the member previously similarly numbered without a capital letter. For example, the casing 10A of FIGURE 4 is intended to be substantially identical with the casing 10 of FIGURES 1, 2, and 3, etc. In FIGURE 4, the remainder of the switch may be identical with that disclosed in connection with FIGURES 1, 2, and 3.

FIGURES 8, 9 and 10 show an embodiment somewhat similar to that of FIGURES 1, 2 and 3, but differing therefrom in several particulars as hereinafter explained. All parts which are the same or substantially identical to similar parts in FIGURES 1, 2 and 3, are shown with the same reference number preceded by the number 1. Thus, casing 10 of FIGURES 1, 2 and 3 becomes casing 110 of FIGURES 8, 9 and 10.

FIGURES 8, 9 and 10 show a normally closed embodiment of the switch. It has an electrically and thermally conductive casing 110, which may be silver plated as described with respect to conductors 10, 10A, and 10B, and except as hereinafter noted, is constructed the same as the switch of FIGURES 1, 2 and 3.

Casing 110 is formed at its open or non-conductive end with a short side wall, section 111, which is relatively thinner than the long side wall section 115, of casing 110. Since the outer diameter of the short side wall section 111 corresponds to the outer diameter of the long side wall section 115, an annular inner shoulder 111A is formed at the inner terminus of short side wall section 111.

The thinner wall portions 111 and 117 may be made by boring out the originally uniform cylindrical wall of the casing 110.

The other end of casing 110 may be provided with an electrically conductive end wall 112 having a flange 113. A first line conductor 116, which may be of copper, like 16 and 16B, may be secured and electrically connected to the casing 110 within flange 113 by crimping as indicated at 113A or by any other suitable method such as soldering, brazing, welding or equivalents thereto, or by sealing with an epoxy resin or the like.

A formed button 114 of molded ceramic or other high temperature resistant insulating material is provided as a closure for the open end of casing 110 and to insulate a second line conductor 118 from contact with the walls of casing 110. The button 114 is formed with a diameter greater than the inner diameter of the thick, longer section 115, but less than the inner diameter of thin side wall 111, so that it may seat within the open portion of casing 110 surrounded by short side wall section 111 without passing shoulder 111A. Button 114 is provided with a central opening 121 which has a section 121A of relatively large diameter and a section 121B of relatively small diameter, preferably no larger than is necessary to accept the unenlarged portions of a second line conductor 118 without binding.

Button 114 is sufficiently thin so that when received in casing 110 against shoulder 111A a small portion 117 of short side wall section 111 protrudes beyond the outwardly disposed surface of button 114 as indicated by the dotted lines of FIGURE 8. The portion 117 may then be rolled, pressed, or otherwise bent over the outer edge of button 114 to form the flange 117A by use of any suitable tool to retain button 114 securely attached to the end of casing 110. Ceramic buttons of suitable material may be easily formed to the shape required for button 114. The second line conductor 118, of material similar to conductors 18 and 18B, extends into casing 110 through ceramic button 114.

However, the conductor 118 preferably is first inserted rightwardly into the button 114 before the button is inserted in the casing 110. The button 114 is then received in casing 110 with the surface containing large diameter opening 121A facing inwardly where it has received the thickened section 118A formed on conductor 118. This prevents outward axial movement of conductor 118 relative to button 114.

Inward axial movement of conductor 118 relative to button 114 may be prevented in several ways. For example, this may be done by crimping, squeezing, upsetting or otherwise deforming of a section 119 of line conductor 118 immediately to the right of section 121B opening 121 in button 114. Inward movement may be prevented by sealant 123 applied after assembly. Alternatively the conductor 118 may be bent slightly, as shown in FIGURE 11.

A contact disc 122 is held against a contact end 120 of second conductor 118 by cooperation of a thermally collapsible pellet 130 and a relatively strong coil-shaped spring 128. A reinforcing disc 122A is placed between the coil spring 128 and the contact disc 122 and prevents damage to contact edge 124. A load distributing disc 134 with a bleed hole 134′ of any desired size is interposed between spring 128 and pellet 130. The disc 134 permits the flow of pellet material when the pellet thermally collapses and protects the solid pellet from bruising action as well as from physical stress caused by spring 128. A relatively light coil spring 132, which may be of stainless steel, like springs 32 and 32A, is provided under compression between disc 122 and button 114 to bias disc 124 away from contact with the contact end 120 of the line conductor 118 when thermally responsive pellet 130 collapses as a result of increase in ambient temperature to or beyond the critical range of the pellet.

A sealing compound 123 of high temperature resistant epoxy resin or other suitable high temperature resistant non electrical conductive material may be deposited over the end of the switch containing button 114 to seal all junctures between casing 110, button 114 and line conductor 118 at that end of the switch.

The embodiment of FIGURE 11 is in many respects similar to that of FIGURES 5 and 7 but with some of the features of the embodiment of FIGURES 8, 9 and 10 incorporated therein and having other notable distinguishing features to be hereinafter pointed out and disclosed.

Reference figures applied to FIGURE 11 will be the same for identical or substantially similar parts as are used in FIGURE 5, except that the prefix numeral 2 will be used in place of the suffix B. Thus casing 10B of FIGURE 5 becomes casing 210 of FIGURE 11.

FIGURE 11 shows a normally open embodiment of the switch. It has an electrically and thermally conductive casing 210, and except as hereinafter noted, is constructed substantially the same as the switch of FIGURE 5.

Casing 210, which may be silverplated as suggested with respect to the other casings 10, 10B and 110, is formed at its open or non-conductive end with a short side wall section 211 which is relatively thinner than the long side wall section 215 of casing 210. Since the outer diameter of short side wall section 211 corresponds to the outer diameter of long side wall section 215, an annular inner shoulder 211A is formed at the inner terminus of short side wall section 211.

The other end of casing 210 may be provided with an electrically conductive end wall 212 having a flange 213. A first line conductor 216, which may be of copper, like 16, 16B and 116, may be secured and electrically connected to the casing within flange 213 by crimping as indicated at 213A or by any other suitable method such as soldering, brazing, welding or equivalents thereto.

A formed button 214 of molded ceramic or other high temperature resistant insulating material is provided as a closure for the open end of casing 210 and to insulate a second line conductor 218 from contact with the walls of casing 210. The button 214 is formed with an outside diameter greater than the inner diameter of long side wall section 215, but less than the inner diameter of short side wall section 211 so that it may seat within the open position of casing 210 surrounded by short side wall section 211 without passing shoulder 211A.

Button 214 is provided with a central opening 221 which has a section 221A forming a relatively large cavity, and a section 221B the inner diameter of which need be and preferably is no larger than necessary to accept the unenlarged portion of the shaft of a second line conductor 218 without binding.

Button 214 is sufficiently thin so that when received in casing 210 against shoulder 211A a small portion 217 of short side wall section will protrude beyond the outwardly disposed surface of button 214, so that it may be rolled over the outer edge of button 214 by use of any suitable tool, thereby retaining button 214 securely attached to the end of casing 210. Like button 114, button 214 may be formed of suitable material in a manner well known in the art.

The second line conductor 218, of like material as conductors 18, 18B and 118, extends into casing 210 through ceramic button 214. It will be understood that button 214 is received in casing 210 with the surface containing large diameter opening 221A facing inwardly to receive a thickened section 218A formed on conductor 218, thus preventing outward axial movement of conductor 218 relative to button 214. Inward axial movement of conductor 218 relative to button 214 is prevented by bending the upper section 219 immediately above section 221B of opening 221 in button 214, but may be prevented by crimping conductor 218, or by the sealant 223, etc.

For the purposes of this invention, line conductor 218 and line conductor 118 may be used as shown and described interchangeably in either of the embodiments of

FIGURES 8 and 11 without changing or departing from the scope of this invention, and it is contemplated that they should be so used, each having been described with respect to a particular embodiment only for the purposes of convenience in description.

In this embodiment of the switch, with button 214 anchored in casing 210, and second line conductor 218 held in button 214, all in the manner heretofore explained, the other parts of this embodiment of the switch are retained in operative relationship in the following manner.

A thermally collapsible pellet 230 is formed with a central aperture 231. Aperture 231 is of sufficient diameter to accept the inward end of second lead conductor 218 which protrudes inwardly of casing 210 beyond button 214. The outward facing surface 233 of pellet 230 abuts the button 214. The pellet 230 is of sufficient length to keep a contact disc 224, which abuts the inwardly facing surface 235 of the pellet 230, out of contact with the end of second line conductor 218 until such time as the thermally responsive pellet 230 collapses as a result of increase in ambient temperature to a degree at or beyond the critical range of the pellet 230.

A coil spring 232, which may be of stainless steel, like springs 32, 32A and 132, is provided under compression stress between disc contact 224 and conductive end wall 212 to impel disc contact 224 against the end of second line conductor 218 when pellet 230 breaks down. Upon the breakdown or collapse of pellet 230 some of the material forming the pellet may be driven into cavity 221A thus facilitating movement of disc 224 against the contact end 220 of conductor 218.

A sealing compound 223 of a high temperature resistant epoxy resin or other suitable high temperature resistant non-electrical conductive material may be deposited over the end of the switch containing button 214 to seal all junctures between casing 210, button 214 and line conductor 218 at that end of the switch.

In all other respects the embodiment of FIGURE 11 is substantially the same as that of FIGURE 5.

It will be readily understood from the foregoing description that each and every one of the novel features disclosed with respect to the embodiments of FIGURES 8, 9, 10 and 11 are applicable and may be used where appropriate with any and all other embodiments of the invention disclosed in this application.

FIGURE 6 is intended to indicate the small size of any of the switches herein disclosed. A switch 5/32″ diameter by 3/8″ long is capable of carrying approximately 15 amperes continuously as compared to much less current carried by previous switches which are much larger in size than the switch of this invention. In FIGURE 6 sufficient reference characters are applied to identify them in connection with FIGURES 1, 2 and 3. However, similar members, with capital letters, are also intended to be illustrated in FIGURE 6, although such reference characters are not applied. The illustration in FIGURE 6 shows the outside surfaces of the switch.

The material of pellet 30, 30B, 30C, 130 and 230 may be of any suitable type, now well known in the art. These pellets, which now may be purchased on the market, have a rigid body which is not collapsible when subjected to any of the pressures of the springs used in the switch as long as the ambient temperature is below the selected temperature to which the switch is to be responsive. However, when the pellet reaches a selected collapsing temperature, which generally is within one or two percent range, then the pellet melts, disintegrates, or otherwise loses its rigidity almost instantaneously, so that the spring action can operate also almost instantaneously to move the contacts from the original position to the new position. Without intending to be limited thereby, applicant points out that the material of the pellets may be of the character described in the patent to Massar et al., No. 2,934,628, April 26, 1960, column 2, lines 20–56; but such material may be of any other similar material now well known and on the market.

For example, when the switch is normally closed, as in FIGURES 1, 2 and 3, then the contacting surfaces at the conductor end 20 and the disc 22 are opened by the action of the weaker spring 32, which now has no opposition from the stronger spring 28. The spring 28 has been forced to move into the molten or crumbled pellet 30. The spring 28 which is U-shaped and compressed as viewed in FIGURE 1 is released, by the melting or other disintegration of the pellet 30, so that the spring 28 thus permits the spring 32 to move the disc 22 leftward to open the contact and open the circuit between the line members 16 and 18.

The disc or slidable contactors 22, 22B, 22C, 122 and 222 preferably have outwardly resilient teeth 54, 54B, 54C, 154 and 254. These teeth may be homogeneous with the respective main central bodies of the discs, as shown in the drawings. These teeth insure positive electrical contact between the disc contactors 22, 22B, 22C, 122 and 222 and the interior surface of the casing 10, 10A, 10B, 110 or 210. Also the teeth 54, 54B, 54C, 154 and 254 maintain the discs in slidable condition and retain the ends of the springs 32, 32B, 132 and 232 securely in place. These contactors may be silver coated, as elsewhere described.

The switches of this invention are easily, accurately and efficiently assembled.

The switch of FIGURES 1, 2 and 3 may first have parts sub-assembled and then finally assembled. The line conductor 18 and the insulative wall 14 may be molded or secured together by a high temperature sealant, such as an epoxy adhesive. The line conductor 16 may be soldered, welded, brazed or crimped on the conductive end wall 12 at the flange 13.

The conductor 16 and casing 10 may be mounted vertically temporarily for assembly with the conductor 16 inserted in supporting holes in flat assembly supports. Then the pellet 30 is dropped into the temporarily open upper end 15. Thereafter the insulator 34, spring 28, sliding contactor or disc 22, and spring 32 may be inserted in casing 10 in the sequence just named. The insulator 34 and spring 28 may previously have been adhered or otherwise secured together before insertion into the casing 10. The spring 32 and disc contactor 22 may previously have been spot soldered together, if desired. Thereafter the previously assembled line conductor and insulative wall 14 may be placed in the end 15 of the casing and secured therein by a high temperature sealant, such as an epoxy adhesive at seam 41 which may be cured therein by heat at end 15 at a temperature lower than the melting or crumbling temperature of pellet 30.

The switches of this invention in all of the figures are not affected by age, unfavorable atmospheres, etc. For example, the silver contact surfaces between discs 22, etc., and the inside surfaces 26, etc., of the casings 10, etc., insure proper movement of the parts when the pellets are thermally collapsed.

These switches are desirable components in many circuits or assemblies. They are not affected by electric surges on the order of at least 3 times normal rating because of their high ampere capacity and low current resistance.

The brass casings 10, etc., efficiently conduct the ambient heat into the pellets 30, etc., so that the pellets are accurately and quickly responsive to the critical limit of the switches.

The switches are smaller in volume than other switches which do not have nearly the ampere capacity. The dielectric or voltage gap produced after the circuit break is relatively large in the switches of FIGURES 1–4, since the smallest gap after the break is the radial distance from the end 20 and 20A of line conductor to the inner surfaces of spring 32.

Very little resistance heat is produced in the switches because of the high conductivity of the line conductors 16 and 18, etc., the discs 22, etc., and the casings 10, etc., and because of the high contact conductivity of the silver contact surfaces between discs 22, etc., and conductor ends 20, etc., at the center and between the edge of the discs 22, etc., and the inner surface of the casings 10, etc. The collapse temperatures of the pellets 30, etc., are less affected by this small amount of resistance heat, as compared to presently available thermal fuses, and even this can be further reduced on the pellets if the sheet insulator 34 is incorporated. The sheet insulator 34 also distributes the compression stresses on the pellet 30 from the strong spring 28.

The relation of the strong spring 28 to the contacts between the disc 22 and the end contact 20 of the conductor 18 removes the necessity of any close longitudinal tolerances. The elasticity and strength of spring 28 take up relatively large longitudinal variances in the parts of the switch. Without the presence of strong spring 28, slight variances in the lengths of the parts or in the accuracy of assembly might cause the contact surfaces at the contact end 20 to be erroneously separated so the switch would be inoperative as a normally closed switch.

This same relationship holds with respect to spring 128, disc 22, and end contact 120 of conductor 118 of FIGURE 8.

The embodiment of FIGURE 4 is assembled substantially in the same manner as the embodiment of FIGURES 1, 2 and 3, except that the conductor 40, 44 and the ring 38 are first fused with the glass disc 36. The ring 38 is secured by adhesive, solder, braze, weld or the like at the seam 42. All other parts and assemblies are the same as in FIGURES 1, 2 and 3.

The embodiment of FIGURE 5 is assembled by first assembling the line conductor 18B, glass disc 36B and ring 38B in the same manner as in FIGURE 4. These parts are then first secured to the end 15B of casing 10B by adhesion, soldering, brazing, welding and the like. Thereafter the pellet 30B is inserted into the casing 10B from the temporarily open end 60 which may be temporarily held in vertical and upper position. The conductor 18B may previously have been mounted in vertical support holes of the character previously described. Thereafter the separator 50, disc 22B and spring 32B are inserted in casing 10B in the order named. The line conductor 16B and flange 13B may previously have been adhered, soldered, brazed, etc., together. Thereafter the conductor 16B and wall 12B may be secured to casing 10B at seam 62 by soldering, brazing and the like. The pellet 30B is relatively distant from the seam 62, and can be protected against damaging heat by use of a suitable heat sink, during soldering, brazing, etc.

The switch of FIGURE 7 is assembled in the same manner as the switch of FIGURE 5. However, the ring 64 is inserted in the casing 10B before the insertion of pellet 30C.

The switches of FIGURES 5 and 7 may also be assembled in a different or reverse manner by the insertion of parts into the right end at 15B. This is particularly true when it is desired to make the end wall 12B integral with the casing 10B in a manner similar to wall 12 and casing 10 of FIGURE 1.

For example, in the switch of FIGURE 5, the wall 12B may be made integral with, or bonded to, the casing 10B. The conductor 16B may be secured to the flange 13B as previously described. Then the following parts may be inserted in the right end 15B in the following order: spring 32B, disc 22B, separator 50 and pellet 30B. Finally, the preassembly 18B, 36B and 38B are inserted and secured to the casing 10B by any low temperature bonding or adhering method.

The switch of FIGURE 7 may be assembled in a similar manner to that described in the immediately preceding paragraph. That is, the end wall for the left end of FIGURE 7 may include parts assembled similarly to

parts 16B, 13B and 12B described in the immediately preceding paragraph. Then the following parts may be inserted in the right end of casing 10B of FIGURE 7: Spring 32B, disc 22C, separator 50C, pellet 30C and ring 64. Thereafter the preassembly 18B, 36B and 38B may be inserted and secured to the casing 10B.

The switch of FIGURES 8, 9 and 10 may be readily assembled as follows. One end of line conductor 116 is inserted into flange 113, which is then crimped as at 113A to hold conductor 116 in place. These may then be temporarily mounted in a vertical position as described with respect to conductor 16 and casing 10 of the embodiment of FIGURE 1. Pellet 130, insulating disc 134, spring 128, contact disc 122 and spring 132 may then be stacked in casing 110 in that order. Button 114 and line conductor 118 may previously have been assembled to each other by slipping button 114 into place over conductor 118 with section 118A received in section 121A of the opening 121 in button 114, and thereafter crimping conductor 118 as shown at 119. This sub-assembly may be placed in casing with the surface 135 containing the larger diameter opening 121A facing inwardly. Button 114 will then come to rest against shoulder 111A and may be secured within the casing 110 by forming or rolling the extended position 117 of wall section 111 over the outwardly facing surface of button 114. Assembly of the switch is thereby complete for most purposes, but if desired either or both ends may be sealed in any suitable manner, as hereinbefore described.

The switch of FIGURE 11 is also very readily assembled, in a somewhat similar fashion. One end of line conductor 216 is inserted into flange 213 which is then crimped as at 213A to hold conductor 216 in place. These may then be mounted temporarily in vertical position as described with respect to similar members of FIGURE 8. Spring 232, contact disc 222 and pellet 230 are then stacked in order inside casing 210. It will be noted that no insulating disc is required in this embodiment as this switch is normally open and no current flows to cause heat which might affect pellet 130 prior to a change of state in the pellet 130. The button 214 and the secured line conductor 218 may be assembled together, and, as shown in the drawings, conductor 218 may be held against movement respective to the button 214 by the simple expedient of bending conductor 218 at the point where it protrudes from section 221B of the opening 221 in button 214.

This sub-assembly may then be placed in the casing 210. Button 214 will then come to rest against shoulder 211A and contact 220 will pass partially through aperture 231 in pellet 230. Button 214 may then be secured inside casing 210 by forming or rolling extended portion 217 of end section 211 over the outwardly facing surface of button 214. This completes assembly of this embodiment of the switch for most purposes, although it may also be sealed thereafter at either end in any suitable manner, as heretofore described.

In any of the assemblies, a suitable heat sink may be used during soldering, brazing, etc., to reduce the heating effect on the interior of the switch sufficiently to prevent activation of the pellet. A heat sink is a heavy piece of heat absorbing metal or the like, such as a sleeve, which absorbs the excess heat of soldering, brazing, etc., adjacent the seam to be joined before such heat can travel to the pellet or the like.

In FIGURES 5 and 7, the headers 14B may be made of a single insulative piece similar to the end wall 14 of FIGURE 1 without the metal ring 38B.

Alternatively the conductor 118 and button 114 may be inserted in the casing 115 before crimping the conductor 118 at 119. The crimping operation may then be performed after or simultaneously with the formation or rolling of the flange 117A.

Also the conductor 218 and button 214 may be inserted in the casing 210 before the bending of the conductor 218, and the bending operation may be performed after or simultaneously with the formation or rolling of the flange 217.

The bending action 219 of the conductor 218 in FIGURE 11 and the crimping action 119 of the conductor 118 of FIGURES 8 and 9 may be used interchangeably.

It is thus to be seen that a very small or minute switch has been provided which has an unusually high ampere capacity, accurate thermal response, and rugged construction. It is quickly, efficiently and accurately assembled, and is relatively low in cost.

This application is a continuation in part of my copending U.S.A. application, S.N. 90,067, now abandoned, filed February 17, 1961, for Thermal Switch.

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

What is claimed is:

1. A switch comprising: a tubular electrically and thermally conductive casing, said casing having an electrically conductive first end wall and an electrically non-conductive second end wall; a first electrical conductor connected to said first end wall; a second electrical conductor passing through said second end wall; a normally solid fusible pellet spring biased to exert outward pressure against one of said end walls; an electrically conductive disc slidable within said casing, said disc having a resilient conductive periphery engaging said conductive casing and having a conductive central portion in electrical contact with said second electrical conductor in one position and out of contact with said second electrical conductor in another position; and a compression spring construction outside said pellet held under compression between said disc and one of said end walls.

2. A switch according to claim 1 in which said spring construction is operable to move said disc out of contact with said second electrical conductor upon fusion of said pellet.

3. A switch according to claim 1 in which said spring construction is operable to move said disc into contact with said second electrical conductor upon fusion of said pellet.

4. A switch according to claim 1 in which said spring construction includes a relatively strong spring and a relatively weak spring.

5. A switch according to claim 1 in which said resilient conductive periphery of said disc is serrated and homogeneous with said disc.

6. A switch according to claim 1 in which a load distributing disc is interposed between said spring construction and said pellet.

7. A switch according to claim 1 in which said electrically non-conductive end wall comprises a molded ceramic button having an axially formed central aperture and having said second electrical conductor firmly mounted against axial movement within said central aperture of said button, and having said casing formed with a relatively thin walled section and an inner annular shoulder at the base of said thin walled section, said button being retained within said thin walled section between said shoulder and an extreme outer portion of said thin walled section flanged over a portion of the outer surface of said button.

8. A switch according to claim 7 in which the outwardly extending portion of said second conductor is deformed immediately adjacent said opening in said button to prevent inward axial movement of said conductor, or is held in place by a sealant.

9. A switch according to claim 7 in which the inwardly extending portion of said second conductor is deformed immediately inside said opening in said button to prevent outward axial movement of said conductor.

10. A switch comprising: a tubular electrically and thermally conductive casing having a closure at each end thereof; one of said closures being electrically non-conductive; a first conductor conductively attached to said casing; a second conductor extending into said casing through said electrically non-conductive closure; a normally solid fusible pellet spring biased to exert outward pressure against one of said closures; an electrically conductive disc slidable within said casing, said disc having a resilient conductive periphery engaging said conductive casing and having a conductive central portion in electrical contact with said second electrical conductor in one position and out of contact with said second electrical conductor in another position; and a compression spring construction outside said pellet held under compression between said disc and one of said closures.

11. A switch according to claim 10 in which said spring construction is operable to move said disc out of contact with said second electrical conductor upon fusion of said pellet.

12. A switch according to claim 10 in which said spring construction is operable to move said disc into contact with said second electrical conductor upon fusion of said pellet.

13. A switch according to claim 10 in which said electrically non-conductive closure comprises a button provided with a large central cavity to receive a portion of the fused material of said pellet upon fusion of said pellet.

14. A switch comprising: a tubular electrically and thermally conductive casing having a closure at each end thereof; one of said closures being electrically non-conductive; a first conductor conductively contacting said casing; a second conductor extending into said casing through said electrically non-conductive closure; a normally solid fusible pellet spring biased to exert outward pressure against one of said closures; an electrically conductive member slidably mounted within said casing, said member having a resilient peripheral conductive engagement with said conductive casing, and having a conductive central portion in electrical contact with said second electrical conductor in one position and out of contact with said second electrical conductor in another position; and a compression spring construction outside said pellet held under compression between said member and said casing to change the electric conductivity between said casing and said electrical conductor upon collapse of said pellet.

15. A tubular metallic casing with an integral metallic wall at a first end, and with a second open end; a first line conductor conductively contacting; an insulating plug inserted and secured in said second open end; a second line conductor passing through said insulating plug into said casing with its second conductor end in said casing; an axially movable electrical conductor electrically contacting the interior of said casing with an outwardly resilient periphery and centrally contacting said second line conductor end and being movable axially away from said second line conductor end; a thermally collapsible pellet with its outer end adjacent said integral metallic wall; a load distributing disc adjacent the inner end of said pellet; a relatively strong spring in said casing with one end engaging said load distributing disc and with its other end cooperatively holding said axially movable electrical conductor in electrical contact with said second line conductor end while said pellet is not collapsed; and a relatively weak coil spring surrounding said second line conductor with one end engaging said plug and with the other end moving said axially movable electrical conductor out of electrical contact with said second line conductor when said pellet collapses.

16. A switch comprising: a tubular electrically conductive casing; a line conductor insulatedly passing into said casing with a fixed contact in said casing; a resilient sliding contact electrically contacting the interior of said casing and movable against said fixed contact; a collapsible thermal pellet and a strong spring outside said pellet cooperating to hold said sliding contact against said fixed contact when said pellet is not collapsed; and a

weak spring moving said sliding contact away from said fixed contact when said pellet collapses.

17. A switch comprising: a cylindrical electrically conductive casing with an electrically conductive end wall and with 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 strong spring outside said pellet with one end adjacent said pellet and with the other end holding said disc against said line contact while said pellet is not collapsed; and a weak coil spring surrounding said second line conductor and moving said disc away from said line contact when said pellet is collapsed.

18. A switch according to claim 14 in which the slidable interior surface of said casing, and the slidable peripheral surface of said member are silver coated to prevent age corrosion of said surfaces and to increase the electrical conductivity and sliding ability between said surfaces.

19. A switch according to claim 14 in which the electrically contacting and relatively movable surfaces in said casing are silver coated to prevent age corrosion of said surfaces and to increase the electrical conductivity and sliding ability between said surfaces.

20. A switch according to claim 14 in which said member having a resilient peripheral conductive engagement with said casing has a plurality of outwardly resilient arms slidably contacting said casing and being homogeneous with said conductive central portion and forming said resilient peripheral conductive engagement with said casing.

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BERNARD A. GILHEANY, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,180,958 April 27, 1965

Phillip Edward Merrill

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 12, line 47, after "contacting" insert -- said first end --.

Signed and sealed this 28th day of September 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents