Dec. 17, 1963 A. C. CAPELLE 3,114,901

FIRE ALARM SYSTEM

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Fig. 1

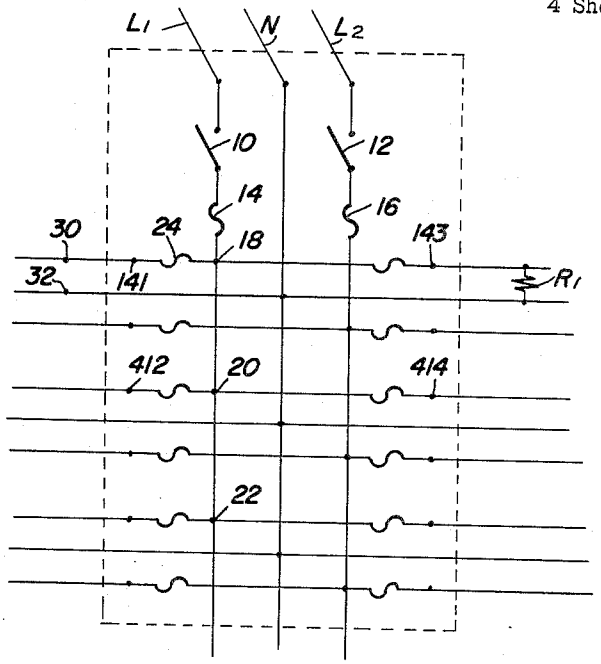


Fig. 4

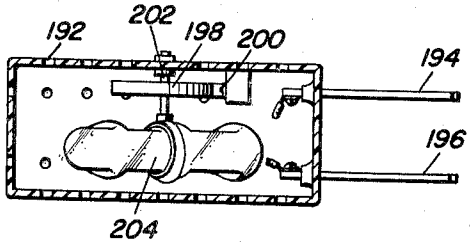
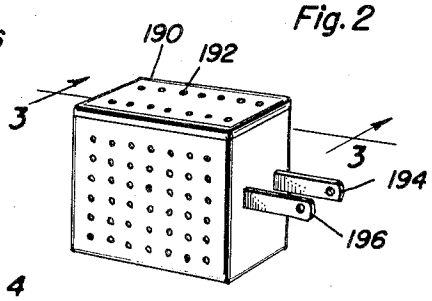


Fig. 2



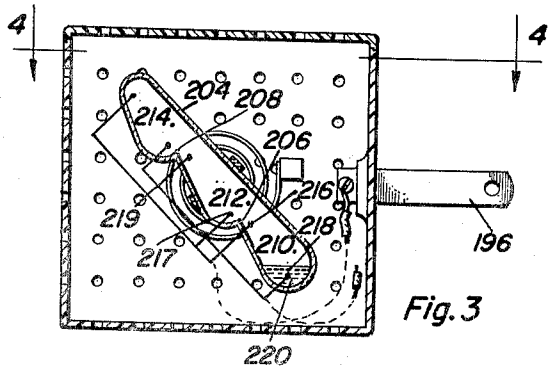


Fig. 3

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Fig.9

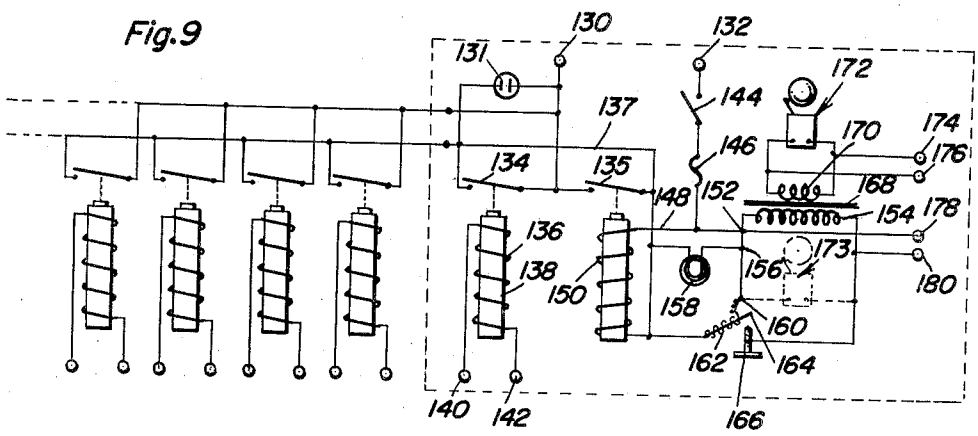


Fig.8

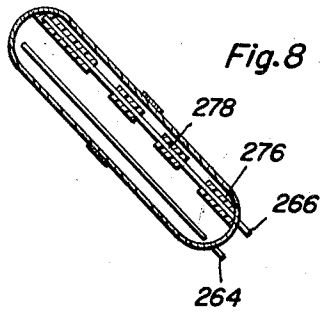


Fig.6

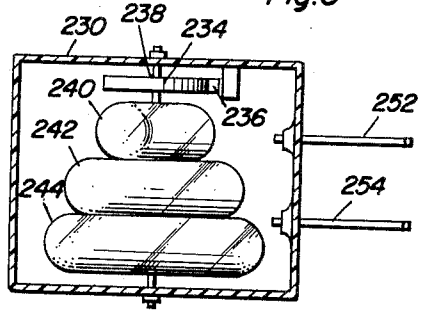
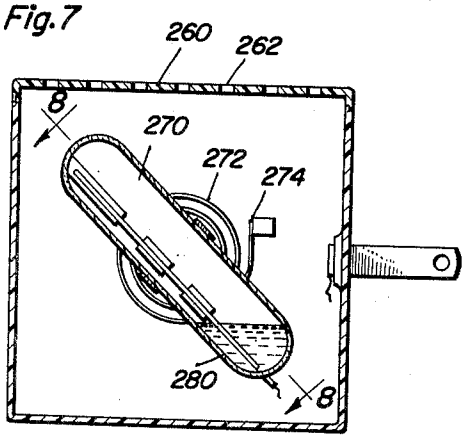


Fig.7



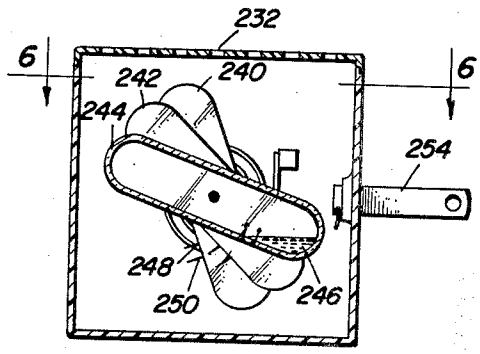


Fig.5

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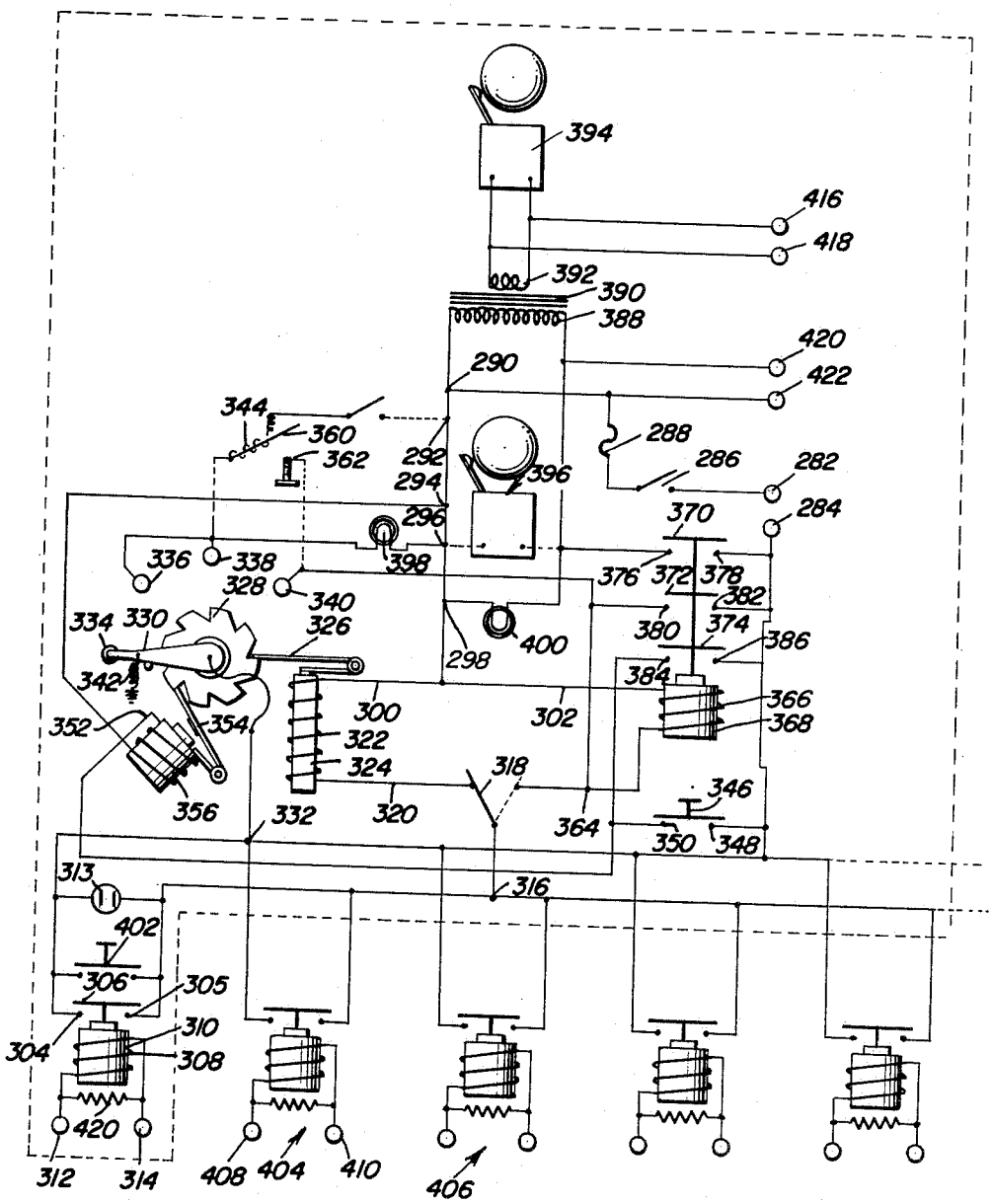
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Fig.10



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FIRE ALARM SYSTEM

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Fig.11

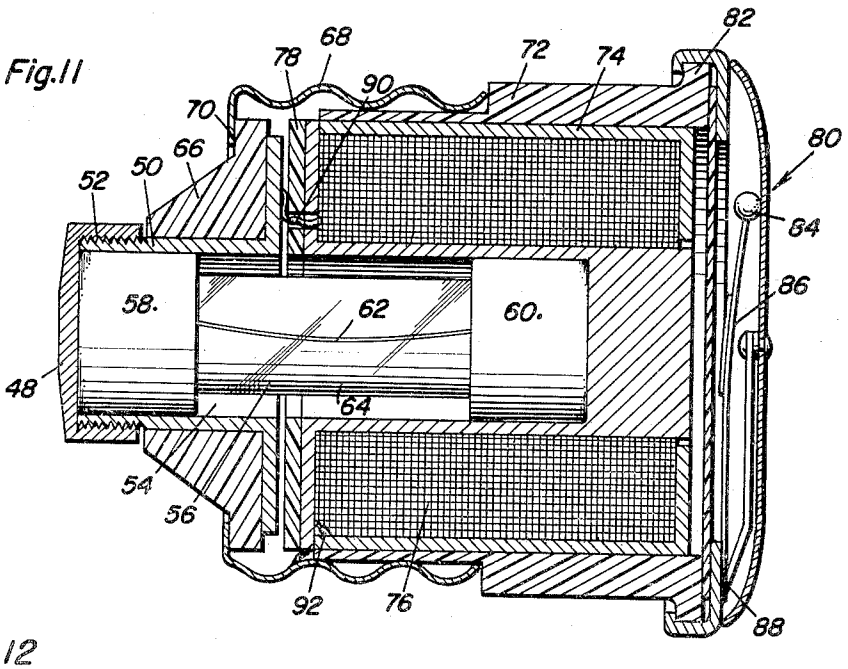


Fig.12

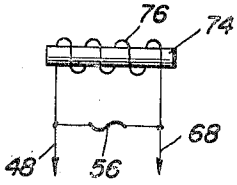


Fig.13

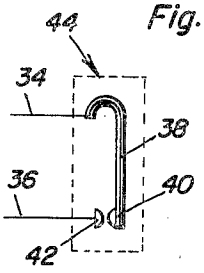


Fig.15

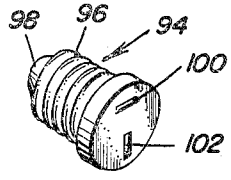
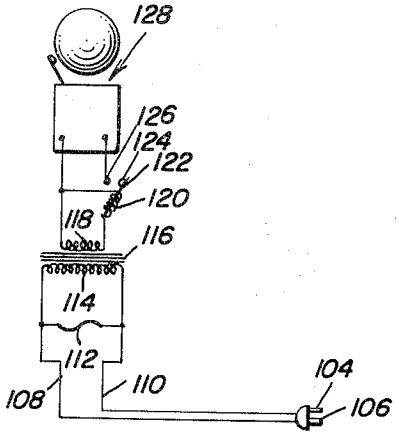


Fig.14



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3,114,901

FIRE ALARM SYSTEM

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Filed Mar. 26, 1958, Ser. No. 724,101
12 Claims. (Cl. 340—227)

This invention relates generally to alarm systems and more particularly to an alarm system particularly designed to detect fires and to actuate an audible signal indicating the fire.

The need for fire alarm protection cannot be neglected. Each year many millions of dollars worth of property are lost due to fire. Further, numerous lives are lost due to fire and panic often resulting therefrom. Needless to say, this property damage and loss of life could be substantially lessened if the proper precautions to prevent fires or at least to properly notify fire department authorities of fires at an early stage were taken. Many fire alarm systems have been developed over the years which have been designed and devised to indicate the existence of a proximate fire. Generally these fire alarm systems detect the presence of a fire by the heat given off by a fire which would, for instance, bend a heat sensitive bimetallic element to close a pair of contacts to an alarm. Most of these former systems have been expensive and cumbersome in that separate alarms were required in various parts of a building where fire detectors were located or lengthy complex wiring was required to connect the various fire detectors to a single alarm. The complexity of the systems, of course, cause them to be expensive and therefore the systems never truly became popular or abundant. An imperative need therefore existed for the development of inexpensive, simple, and reliable fire alarm system. It is therefore the principal object of this invention to provide a novel and improved fire alarm system which is characterized particularly by its simplicity in installation and construction and its reliability for detection and alarm indication.

In order to minimize production and installation costs, it has been found that to utilize existing building circuitry materially lessens any expense that may be incurred through installation of this protective system. Therefore, it is a further object of this invention to provide a fire alarm system which utilizes detector elements particularly designed to be plugged into existing building circuitry to use the circuitry for conveying actuating impulses to alarm devices.

A still further object of this invention is to provide novel and improved plug-in fire detector elements which form an integral part of the fire alarm system.

It is a still further object of this invention to provide a novel and improved fire alarm system which is capable of detecting defective and shorted wiring between walls, ceiling and floors and which will sound an alarm before a fire actually starts.

It is more particularly an object of this invention to provide a fire alarm system which may discriminate between actual fires and normal short-circuits in the building circuitry.

It is a still further object of this invention to provide a novel fuse-alarm element which may be utilized as an integral part of the fire alarm system.

It is a still further object of this invention to provide a novel and improved plug-in fire alarm system which may be incorporated with any existing building electrical distribution system.

In accordance with the above stated objects, below is described in particularity, the principles of construction and operation of the elements comprising the novel fire alarm system. Of course, the principal design considerations were to achieve the maximum fire protection at the minimum of installation and maintenance cost. To do this, fire detector elements were developed which were temperature responsive and reacted to a fire so as to close a pair of electrical contacts. The fire detector and electrical contacts are intended to be inserted in a normal electrical outlet box. When the fire or heat causes the contacts of the fire detector to close, the electrical distribution line will be shorted and a line fuse in the panel box will blow. (For all disclosed embodiments except one, the systems are equally effective where line breaker switches are used instead of fuses.) This will bring a portion of the hot wire down to neutral through the closed contacts of the fire detector. Elements of an alarm device connected between the portion of the hot wire brought down to neutral and a second hot wire will then be energized to actuate an audible alarm. Before the fuse blew, of course, the alarm device remained unenergized because it was connected at both its terminals to a pair of hot wires having no voltage drop therebetween. Though the system would detect all fires, a normal blown fuse caused by a short circuit would likewise actuate the audible alarm. Therefore, the further more complex and more expensive system is disclosed for discriminating between the fire and a conventional short-circuit. This further system utilizes a step relay which is stepped by increasing temperatures. Therefore, a conventional short-circuit which is generally of a single duration will not actuate an alarm device but fire with an ever increasing temperature will continue to step the relay until, after a predetermined number of steps, the audible alarm is actuated. A further feature of the invention allows for a semi-discriminating system which would have a cost falling somewhere between the cost of a non-discriminating and a discriminating system. The semi-discriminating system includes a time delay device which provides a time interval between the moment the fuse blows and the audible alarm is actuated. This enables a person to remove the blown fuse and the short circuit cause (which is generally known) before the alarm is actuated.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a schematic diagram of a conventional building wiring system;

FIGURE 2 is a perspective view of one embodiment of fire detector element for use in a discriminating fire alarm system;

FIGURE 3 is a vertical sectional view taken substantially along the plane 3—3 of FIGURE 2;

FIGURE 4 is a horizontal sectional view taken substantially along the plane 4—4 of FIGURE 3;

FIGURE 5 is a sectional view of a second embodiment of a fire detector utilized in discriminating fire alarm systems;

FIGURE 6 is a sectional view taken substantially along the plane 6—6 of FIGURE 5;

FIGURE 7 is a sectional view of a third embodiment of a fire detector for utilization in a discriminating type fire alarm system;

FIGURE 8 is a sectional view taken substantially along the plane 8—8 of FIGURE 7;

FIGURE 9 is a circuit diagram of a semi-discriminating fire alarm system;

FIGURE 10 is a circuit diagram of a discriminating fire alarm system;

FIGURE 11 is a sectional view through a fuse-alarm

device to be utilized in conjunction with the fire alarm system;

FIGURE 12 is a circuit diagram of the device of FIGURE 11;

FIGURE 13 illustrates a fire detector in its most basic form;

FIGURE 14 illustrates the circuit of a basic semi-discriminating fire alarm system;

FIGURE 15 illustrates a polarized plug device to be utilized in conjunction with the circuit of FIGURE 14.

With continuing reference to the drawings, and initial reference to FIGURE 1, the circuit there presented represents one form of a conventional electric distribution system. Of course, many building electrical distribution systems are used and the teachings of this invention can be well adapted to any conventional system. In the system of FIGURE 1, L_1 and L_2 represent a pair of lines carrying current from a utility distribution transformer to the building distribution system. The line N represents the neutral line which is generally connected to the building ground which, for instance, may be electrically connected to a water pipe. Conventionally, approximately 110 volts will exist between the neutral and either line with approximately 220 volts existing between the lines. 10 and 12 represent main switches for providing electric power to the building circuitry. Fuses 14 and 16 represent main line fuses for protecting the wiring from an overload and preventing a fire which may be caused by a current overload. A plurality of leads as at 18, 20 and 22 are tapped from the lines. As shown in FIGURE 1 each of the leads is equipped with a separate fuse as is shown at 24. A resistor, R_1, is shown electrically connected between the line L_1 and the neutral wire. This resistor R_1, is intended to represent any 110 volt load as, for instance, a light. Of course, any 110 volt load would be fed in the same manner as R_1 between one of the lines, either L_1 or L_2, to the neutral wire. Terminals 30 and 32 on FIGURE 1 represent two contacts of wall outlet which may, for instance, receive any of the fire detectors to be more specifically described below.

With initial reference to FIGURE 13, numerals 34 and 36 represent a pair of male conductor members adapted to be electrically received in female contacts 30 and 32. The conductor 34 is electrically connected to a bimetallic strip 38 carrying a contact 40 on the end thereof. A contact 42 is placed proximate the contact 40 and is adapted to be contacted thereby upon a temperature increase in the vicinity of the fire detector generally represented by 44. It will be apparent that contacts 40 and 42 are normally opened and only in the event of a fire or an extreme rise in temperature will they contact. Upon a direct connection of the contacts 40 and 42, the points 30 and 32 will be short circuited and the fuse 24 would normally blow. By utilizing the device shown in FIGURES 11 and 12 in place of the fuse 24, the short circuiting of points 30 and 32 due to a fire proximate the bimetallic strip 38 will cause the device of FIGURE 11 to become energized so as to create an audible alarm.

The device of FIGURE 11 includes a conductive cap portion 48 which may be threadedly engaged upon a neck portion 50 as at 52. Held within a hollow 54 created through the neck portion 50 is a fuse 56 including conventional conductive end portions 58 and 60 bridged by a fusible member 62 surrounded by a transparent cylinder 64. An insulative collar portion 66 surrounds the neck 50. A metallic threaded portion 68 is affixed to the collar as at 70 and extends rearwardly to a second insulative portion 72 to which it is also affixed. The second insulative portion 72 surrounds an electrically conductive magnetic core portion 74 upon which is wound a bell core 76. An insulated spacer 78 electrically separates the neck portion 50 from the core 74. The fuse 56 sets in a hollow in the core 74 and electrically connects the cap 48 with the core 74. A bell structure 80 is carried by flanges 82 on the rear of the insulative member 72. The bell 84 is carried on a resilient elongated strip 86 which is supported as at 88. FIGURE 12 illustrates the schematic wiring of the device of FIGURE 11 wherein 74 again represents the core and 76 the conductive coil. 68 represents the threads which would conventionally form one terminal of the circuit when utilized in a conventional fuse outlet. The cap 48 would generally form the second terminal with the fuse 56 connecting them and shunting the coil 76. The electrical connection through this device may be easily followed. That is, from cap 48, an electrical path is defined through collar 50 to wire 90 to coil 76 through wire 92 to core 74 to the threaded portion 68. A parallel path may be followed through the fuse from cap 48 to end portion 58, fusible strip 62, end portion 60, to core 74 and threaded portion 68.

When the device of FIGURE 11 is utilized in the place of fuse 24, under normal circumstances a circuit will function in a conventional manner. However, when the contacts 40 and 42 of fire detector 38 close the points 30 and 32 are shorted and fusible strip 62 will open, thereby opening the circuit through fuse 56. This action will place a 110 voltage across the coil 76 and cause the bell structure 80 to become actuated and give off an audible signal. More particularly, the voltage will be applied across the coil 76 because the point 30 will be connected to the neutral wire through the contacts 40 and 42 of the fire detector 38. This fire detector system clearly then indicates the presence of a fire without any external wiring between the fire detector and the audible alarm. However, any normal short in the lines caused by a reason other than fire would likewise actuate the alarm structure 80, thereby resulting in a false alarm. It should of course be apparent that instead of utilization of the device of FIGURE 11 for fuse 24, it may replace fuse 14 just as easily if the proper fuse values are taken into account.

An alternative to the fuse-alarm shown in FIGURE 11 would be the utilization of the devices illustrated in FIGURES 14 and 15. More particularly, with the fire detector 44 still connected across the points 30 and 32, a female polarized outlet 94 may be utilized instead of either the fuse 14 or 24. The outlet 94 may be accommodated in the same way as the conventional fuse having a threaded portion 96 and an end contact portion 98. The portions 96 and 98 electrically communicate with a pair of female receptacles 100 and 102 which are polarized as may be seen in FIGURE 15. The receptacles 100 and 102 may electrically accommodate a pair of male prongs 104 and 106 which electrically extends through leads 108 and 110 to a parallel combination of a fuse 112 and a transformer primary coil 114. The coil 114 is wound on a core 116 which also carries a secondary coil 118. In series with the secondary coil 118 is a heating coil 120 which is adapted to control bimetallic arm 122 carrying a movable contact 124 adapted to electrically contact a fixed contact 126. The fixed contact 126 electrically extends to a conventional bell 128.

In the utilization of the devices of FIGURES 14 and 15 when the contacts 40 and 42 of the fire detector 44 closes, an overload current will be drawn and the fuse 112 in series with the contacts 40 and 42 will blow. When fuse 112 opens, a voltage will be applied across the primary coil 114 which would be induced in the secondary coil 118. A current through coil 120 will tend to heat the bimetallic strip 122 which will after a predetermined time carry the contact 124 into electrical connection with contact 126. The bell 128 will then, of course, be actuated. It is noted that the heating coil 120 provides a time-delay between the time of the opening of fuse 112 until the time of the bell ringing of bell 128. This time-delay is provided as an advantage over the device of FIGURE 11. That is, the device of FIGURE 11 is non-discriminating in that a fire or a conventional short circuit will actuate the alarm in the same manner. The device of FIGURE 14 will not, however, immediately actuate the alarm. Generally, when an individual plugs in

an appliance and the fuse blows, he is aware of the cause of the short circuit or the overload. He may then proceed to the fuse box to replace the blown fuse, as at 112, and the bell 128 will not be ringing in this interim. However, if the fuse blowing is caused by a fire, he will not be aware of it and after a predetermined time a bell 128 will notify him of the fire. We will therefore speak of the device in FIGURE 14 as a semi-discriminating circuit. That is, though the circuit itself cannot discriminate between a fire and a short, a person is allowed sufficient time in order to remove the shorting cause.

Next referring to the circuit of FIGURE 9, there is shown a semi-discriminating fire alarm system which may be utilized with the distribution system of FIGURE 1 and is adapted to accommodate a plurality of fire detectors. More particularly, numeral 130 represents a terminal adapted to be connected to the neutral wire shown in FIGURE 1 and numeral 132 the terminal to be connected to either one of the lines shown as L_1 or L_2. The neutral terminal 130 extends to a plurality of normally open knife blade switches as 134 which are controlled by a series of relay coils 136. The principles of this circuit can best be explained by reference simply to the elements enclosed in the dotted line rectangle with the understanding that the relays shown outside of the dotted line rectangle refer to devices electrically connected in parallel with the relay 136 and knife blade 134 and operate in an identical manner. The relay coil 136 is wound on a magnetic core 138 and terminates in a pair of terminals 140 and 142 which are intended to be connected in the distribution circuit on FIGURE 1 as at points 141 and 143. It should be apparent that under normal operation no voltage will be impressed across the terminals 140 and 142 in that the points 141 and 143 are connected to the same voltage line L_1. The terminal 132 which is connected to a hot line, L_1 or L_2, extends through a switch 144 and a fuse 146 to a terminal 148 on relay coil 150, to a terminal 152 on a transformer primary winding 154, to a terminal 156 on one side of an indicating lamp 158, to a terminal 160 on one side of a heating coil 162. The other side of all these elements extend to neutral terminal 130 through normally open switches as knife blade 134 and knife blade 135.

From the foregoing it should be apparent that when knife blades 134 and 135 close, the alarm system will be energized. The course of events may be as follows: (1) A short circuit will occur across points 30 and 32 due to the action of fire detector 44. (2) Fuse 24 will blow. (3) The potential of point 141 will therefore drop to the neutral line potential at point 32 and a voltage will therefore exist between points 141 and 143 and therefore the relay coil 136 which was formerly simply floating in the circuit will be energized through terminals 140 and 142 connected respectively to the terminals 141 and 143. (4) Knife blade 134 will close and line 137 will be established as a neutral line directly connected to terminal 130. (5) Indicating lamp 158 will light. (6) Relay coil 150 will become energized. (7) Knife blade 135 will close and thereby maintain the relay coil 150 in its energized state (that is relay coil 150 acts as a holding relay). (8) The heating coil 162 will begin to heat. (9) The bimetallic strip 164 will close and contact terminal 166. (10) The primary transformer 154 will become energized and the core 168 will induce a signal in the secondary coil 170 thereby actuating bell 172.

From the foregoing, it is apparent that FIGURE 9 with the time-delay heating coil 162 included therein shows a semi-discriminating fire alarm system. That is, the short across points 30 and 32 need not be caused by a fire but any conventional shorting of these points will have the same effect on the circuit of FIGURE 9. However, it is assumed that a person will be aware of a short caused by an appliance and the time-delay coil 162 will give the individual ample time to replace the blown fuse at 24. However, if it be desired to utilize the system of FIGURE 9 as a non-discriminating system, it is only necessary to remove the heating coil 162 or to utilize the bell in a manner shown by the dotted line bell 173. The indicating light 158 visually indicates the short circuit across points 30 and 32. Terminals 174 and 176 are auxiliary terminals which may be utilized to acuate other bells or alarm devices. Likewise, terminals 178 and 180 may operate further alarm devices on a non-discriminating basis. The holding relay coil 150, by maintaining a plate 135 connected to the neutral wire, continues to actuate the alarm though the voltage across the terminals 140 and 142 be removed. As noted above, any of the plurality of relays shown to the left of the dotted line marks may likewise actuate the system in the same manner as the relay coil 136.

Further, in order to provide fire protection in the fuse panel area, the invention contemplates the installation of an outlet 131 between the terminal 130 and lead 137. With a fire detector as illustrated in FIGURE 13, for instance, operatively carried by outlet 131, a fire will cause contacts 40 and 42 to contact to actuate relay coil 150 to energize the alarm circuitry.

The circuit of FIGURE 10 discloses a discriminating fire alarm system which may also be utilized as a non-discriminating or semi-discriminating system. Before going into the details of the circuitry of FIGURE 10, it would appear advantageous to discuss the discriminating fire detectors to be used in conjunction therewith.

The fire detector of FIGURE 2 includes rectangular perforated housing 190 perforated as at 192 and having electrically conductive male prongs 194 and 196 adapted to be electrically received within female receptacles as at 30 and 32 of FIGURE 1. The perforations 192 allow the ambient air to pass therethrough and effect a thermal spring 198 which is supported to the housing as at 200. A heating effect of the ambient air passing through the perforations 192 causes the thermal spring 198 to rotate a shaft 202 journaled in the housing 190. The shaft 202 terminally carries a container 204. The container 204 is substantially cylindrical with a series of ridges contained internally as at 206 and 208. The ridges 206 and 208 separate the container 204 into a plurality of pool areas as 210, 212 and 214. Each of the pool areas carries a pair of electrical contacts as 216 and 218. The terminals 216 and 218 are adapted to be electrically bridged by a pool of conductive fluid, as mercury, designated as 220. The operation of this device is as follows:

Upon an increase in the temperature of the ambient air, the thermal spring 198 will rotate the shaft 202 in a manner such that the mercury pool 220 bridges the gap between 216 and 218. Upon a further increase in ambient temperature the container 204 will tip further as it is carried by shaft 202 so that the mercury pool 220 then bridges terminal 216 and 217. However, the terminals 216 and 217 are electrically connected together and the bridging effect is therefore of no consequence. However, as the container 204 continues to be carried by shaft 202 and due to the rise in the ambient temperature, the mercury pool 220 will bridge contact 217 and 219. Upon a further increase in temperature the bridging will again be broken and then restored. The ambient temperature therefore has the effect of intermittently shorting the male prongs 194 and 196 which are electrically connected as in parallel with terminals 217 and 219 as the ambient temperature increases. With the male prongs 194 and 196 electrically connected in the distribution circuit of FIGURE 1 across points 30 and 32, the fuse 24 will blow. As the electrical bridging effect of the mercury pool 220 is intermittently broken, the point 30 intermittently assumes the neutral wire potential. The effect of this intermittent bridging and breaking on the accompanying circuitry will be discussed more fully in connection with the circuit below.

FIGURE 6 illustrates an alternative embodiment to the device illustrated in FIGURES 2 through 4. The embodiment of FIGURE 6 likewise has housing 230

which would also be perforated as at 232 for passing the ambient air to a thermal spring 234 supported relatively to the housing at 236 and adapted to rotate a shaft 238 journaled in the housing 230. The shaft 238 carries three closed cylindrical containers as 240, 242 and 244 which are fixed to the shaft 238 at varying angles as clearly shown in FIGURE 5. Each of the containers 240, 242 and 244 carries a pool of conductive fluid as mercury 246 in the bottom thereof and a pair of terminals as at 248 and 250. The terminals 248 and 250 are of course electrically connected to the male prongs 252 and 254 for electrical connection in the circuit of FIGURE 1 at 30 and 32. It should be further apparent that the pairs of terminals on the respective containers are connected in parallel with the male prongs 252 and 254.

In operation, the embodiment of FIGURES 5 and 6 passes the ambient air and the temperature effects the thermal spring 234 so as to rotate the shaft 238 carrying the containers 240, 242 and 244 therewith in a manner such that the conductive fluid in each container bridges a pair of terminals as 248 and 250 for electrically shorting the male prongs 252 and 254. The angularity of the respective containers is so adjusted that an increase in ambient temperature causes an intermittent shorting and opening of the respective male prongs 252 and 254. For a purpose to be described more specifically below in conjunction with the explanation of the circuit of FIGURE 10.

FIGURES 7 and 8 illustrate a still further embodiment of the fire detector of the discriminating type again having a perforated housing 260 perforated as at 262 and carrying a pair of male prongs connected to a pair of elongated electrodes 264 and 266. The elongated electrodes 264 and 266 are carried on the inner perimeter of a cylindrical container 270 in a parallel relationship. The container 270 is supported on a shaft which may be rotated by thermal spring 272 supported by the housing at 274 and responsive to the ambient temperature. The elongated electrode 266 is intermittently insulated as at 276 and 278 etc. and the container 270 again contains a pool of conductive fluid as mercury at 280.

In operation, as the ambient temperature increases as caused by fire, the thermal spring 272 will tend to tip the container 270 in such a manner so that the conductive fluid 280 electrically bridges the elongated electrode 264 and 266 shorting the male prongs across the points 30 and 32 of FIGURE 1. A further rise in temperature and a further tipping of the container 270 will break the bridging relationship of the mercury pool 280 in that the insulation 278, for instance, will break the electrical contact between elongated electrodes 264 and 266. It should further be apparent that as the ambient temperature increases, the container 270 will tip further and again the male prongs will be subjected to an intermediate shorting and opening at its terminals.

Now particularly referring to the circuitry of FIGURE 10, terminal 282 is adapted and intended to be connected to either one of lines L_1 or L_2 while terminal 284 is intended to be connected to the neutral wire of FIGURE 1. Therefore, terminal 282 is a hot terminal which proceeds through a switch 286 and a fuse 288 to one side of a primary coil 388 at 290 to one side of a heating coil 344 at 292, to one side of a relay coil 356 at 294, to one side of an indicating lamp at 296, to one side of a second indicating lamp 400 at 298, to one side of a second coil 322 at 300, and to one side of a third coil 366 by line 302. All these elements could be actuated upon the connection of the neutral wire to the other side of the elements. The neutral wire 284 may be directly traced to a terminal 304 proximate to bridging bar 306 adapted to be actuated by a relay coil 308 on magnetic core 310. The terminals of the relay coil 308 are designated as 312 and 314 and are adapted to be electrically connected across the terminals 141 and 143 of

the circuit of FIGURE 1. Considering the three embodiments of the fire detectors as denoted above, upon an initial short-circuiting of points 30 and 32, terminal 141 will assume the potential of the neutral line and potential will therefore be impressed across terminals 141 and 143 connected to terminals 312 and 314, thereby actuating relay coil 308 and moving bridging bar 306 into contact with point 304. The bridging bar 306 further applies the neutral potential of terminal 304 to terminal 305. The neutral potential there proceeds to terminal 316 and through switch 318 to one side 320 of a relay coil 322 on magnetic core 324. The relay coil core combination 322 and 324 are adapted to actuate a pivotally mounted armature 326 which moves the ratchet or step gear 328 clockwise. The gear 328 carries an arm 330 therealong. The arm 330 is electrically connected to the neutral line as at 332 and is adapted to electrically contact any of the terminals 334, 336, 338 and 340. This diagram arbitrarily shows a maximum of three steps for the relay but theoretically there would be no limit. The arm 330 is biased conuterclockwise by a spring 342. Assuming that the circuit of FIGURE 10 is initially as shown, and that when one of the fire detectors intermittently shorts the points 30 and 32 on the diagram of FIGURE 1, the relay coil 308 will cause bridging bar 306 to connect terminals 304 and 305 and the neutral potential will thereby be applied on one side of the relay coil 322 at 320. The armature at 225 will tend to rotate the ratchet gear 328 in a clockwise direction carrying the arm 330 into contact with the terminal 336. The arm 330 will apply a neutral potential to the contact 336 and a heating coil 344 which may be optionally utilized will start to heat if the contacts of switch 346 are closed. With the heating coil included in the circuit, the circuit is semidiscriminating that is, if the cause of the short circuit and the blown fuse 24 is removed, the circuit may be reset by the depression of a push switch at 346 which will bridge terminal 348 and 350 and apply a neutral potential to holding relay 352 pulling arm 354 toward the core 356 allowing the spring 342 to carry the terminal 334. If, however, the cause of the short is not removed the heating coil 344 will ultimately cause bimetallic strip 360 to contact fixed terminal 362 to apply a neutral potential at point 364 and actuate relay coil 366 on core 368. An actuation of relay coil 366 will cause the ganged bridging bars 370, 372 and 374 to contact respective terminals 376 and 378, 380 and 382 and 384 and 386. As these bridging bars fall, it will be apparent that a neutral voltage will be applied to the transformer primary 388 having transformer cores 390 and secondary 392. Apparently, this will actuate the audible alarm in the form of a bell 394.

Retrogressing, if the heating coil 344 were not included in the circuit, the circuit of FIGURE 10 would not be semi-discriminating but would be discriminating in that a conventional short circuit would move the arm 330 to the first position 336 where it would rest and no alarm would sound. However, if a fire actually did exist and the fire detectors intermittently energized the relay coil 308 three times, the arm 330 would be moved to terminal 340 so that the neutral potential would be applied to point 364 and relay coil 366 would then be actuated to drop the bridging bars 370, 372 and 374 to actuate the alarm devices. Even with the heating element 344 in the circuit shown in FIGURE 10, a fire will be detected by the operation of a circuit actuated through contact point 340 as follows: Upon the short-circuiting of lines 30 and 32 due to a fire being detected by a thermal switch as shown in FIGURE 2, the fuse 24 will be caused to blow thus maintaining points 141 and 143 which are connected to points 312 and 314 of FIGURE 10 at a different potential. This will cause relay 308 to be actuated causing bar 306 to bridge contacts 304 and 305. This will connect the neutral line to one side of relay 324 causing it to be actuated and rotating the

ratchet gear 328 to point contact 336. This occurs when the mercury in the switch shown in FIGURE 2 bridges the first pair of contacts therein. Upon subsequent thermal energy being passed through the switch the tube holding the mercury will be further rotated and the circuit will be broken. However, upon further rotation of this tube due to the increased thermal activity due to a fire a second set of contacts will be bridged again actuating relay 308 connecting the neutral line to relay 324 and causing the ratchet gear and contact arm 330 to move to a point contact 338. Of course, the ratchet gear is held in its adjusted position by means of a pawl 354 electrically associated with the relay 356. Upon continuing thermal activity, the circuit is again broken but contact arm 330 will remain at point contact 338. Then, before the bimetallic element 360 has sufficient time to close contact 362, the mercury pool will further be rotated to a position where a third pair of contact elements is bridged again actuating relay 308 which in turn allows actuation of ratchet gear 328 and contact arm 330 to move the same so that contact arm 330 is in contact with point contact 340. It should be apparent that the heating element 344 causes closure of switch 360 to contact 362. The switch 360 is slow acting and will not close until after the mercury switch shown in FIGURE 2 has rotated to its third position. When this occurs, relay 366 is placed in the circuit and will be actuated to then sound the alarm. However, with the heating coil 344 in the circuit, the circuit of FIGURE 10 becomes semi-discriminating, since bimetallic element 360 is slow acting and before contact 362 is closed, one may replace the fuse which has been blown and correct the short circuit cause before the alarm is actuated. However, if the short circuit cannot be located and there is no fire, the arm 330 will be held in contact with terminal 336 since the thermal switch will not be activated any further thereby causing the continued heating of the bimetallic element 360 and actuation of the alarm system. If there is a fire the arm 330 will move to terminal 340 as described above and actuate the alarm 394 before contact 362 has been closed.

Numerous modifications are of course available on the circuit of FIGURE 10 without departing from the teachings of the invention. Particularly, a bell 396 may be utilized as shown if an auxiliary audible alarm was desired. Further, the function of the indicating lights as at 398 and 400 should be apparent. The indicating light 398 would immediately alight upon an initial step of the gear 328 carrying the arm 330 into contact with terminal 336. Indicating light 400 would alight upon the energization of coil 366 and the dropping of the bridging bars 370, 372 and 374.

By moving the contact plate 318 to its dotted line position the circuit of FIGURE 10 would be non-discriminating in that an initial energization of the coil 308 would immediately energize the coil 366 placing the bridging bars in a position to apply the necessary neutral wire to actuate the circuit alarms. Further, the circuit includes a switch as at 402 for enabling a person to manually test the circuitry of this invention to see whether it is in order. That is, the bridging bar 402 would obviously serve the same function as the bridging bar 306 to energize the circuit. A plurality of relay coils as 404, 406, etc. may further be utilized to energize the circuit in the same manner as the relay coil 308. For example, where the terminals 312 and 314 were intended to be connected across the terminals 141 and 143 of FIGURE 1, terminals 408 and 410 may be utilized across a pair of terminals as 412 and 414.

It is further apparent that auxiliary terminals such as low voltage terminals at 416 and 418 may be utilized to actuate supplementary alarm devices while high voltage terminals 420 and 422 may be used to energize high voltage alarm devices. The system may optionally include an outlet as at 313 to provide fire protection in the fuse panel area which is generally devoid of outlets. The operation of a fire detector carried in outlet 313 would be similar to the explanation given for the outlet 131 of FIGURE 9.

To summarize the systems comprising the teachings of this invention, a fire alarm system has been disclosed which provides for reliable fire protection while utilizing relatively simple plug-in fire detectors and conventional building electrical distribution circuitry to actuate alarm devices. The circuits may be divided into three classes. That is, the invention discloses a non-discriminating, semi-discriminating, and discriminating alarm systems. The first alarm system reacts equally to a fire or a conventional short circuit. The second reacts to either a conventional short or a fire but provides a time-delay for allowing an individual to change a fuse before the alarm is actuated. The third reacts exclusively to a rise in temperature such as caused by a fire. In any of the systems holding relays may be included to continue the alarm sounding until the cause of alarm is removed or the circuit reset. It is to be particularly noted that by selective utilization of the switches 346 and 318, the circuit of FIGURE 10 may operate as a non-discriminating, semi-discriminating or discriminating circuit.

Individual design considerations are of course important in the utilization of any of these circuits in particular systems. That is, for example, while utilizing the circuit of FIGURE 10 with the electrical distribution system of FIGURE 1 shunt resistors as at 420 must be necessarily included with the relay coil 308. These resistors must be included so that the coils as 308 will become deenergized. The shunt resistors are necessary because as is well realized the fire detectors are in parallel with all the loads connected in that circuit and after a fuse blows are in series with the coil as at 308. The relatively small load of the coil 308 would cause the coil to remain energized through the low resistance parallel combination of all the connected resistive loads even after the fire detector contacts open. Obviously, the circuit of FIGURE 10 requires the intermittent energization and deenergization of coil 308 for satisfactory discriminating operation. Therefore, the shunt resistor 420 must be utilized to balance the loads so that a sufficient voltage does not remain across the coil 308 to keep it energized.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A fire detection and alarm system for use in conventional electric distribution systems comprising a temperature responsive normally open fire detector switch electrically connected between a live and neutral line, a fuse electrically connected in series with one of said lines adapted to blow upon a closure of said fire detector switch to produce assigned and alarm means energizable in response to said blowing of the fuse.

2. A fire detection and alarm system for use in conventional electric distribution systems comprising a temperature responsive normally open fire detector switch electrically connected by low resistance conductor means between a live and neutral line, a fuse electrically connected in series with one of said lines adapted to blow upon a closure of said fire detector switch to produce a signal and alarm means energizable in response to said blowing of the fuse, said alarm means being normally electrically connected across a pair of like potential points, means for changing the potential of one of said points upon the closure of the fire detector switch and the blowing of the fuse.

3. A fire detection and alarm system for use in con-

ventional electric distribution systems comprising a temperature responsive normally open fire detector switch electrically connected by low resistance conductor means between a live and neutral line, a fuse electrically connected in series with one of said lines adapted to blow upon a closure of said fire detector switch and alarm means energizable in response to said blown fuse, said alarm means being normally electrically connected across a pair of like potential points, means for changing the potential of one of said points upon the closure of the fuse detector switch and the blowing of the fuse, said alarm means including an alarm device and time-delay means for deferring the actuation of said alarm device until a predetermined interval after the energization of said alarm means.

4. A fire detection and alarm system for use in conventional electric distribution including a plurality of individual circuit systems comprising a plurality of normally open fire detector switches electrically connected by low resistance conductor means between a live and neutral line, a plurality of fuses, each of said fuses electrically connected in series with one of said lines in one of said plurality of circuits and adapted to blow upon a closure of one of said fire detector switches, a plurality of relay coils normally electrically connected across a pair of like potential points, means for changing the potential of one of said points upon the closure of a fire detector switch and the blowing of a fuse for energizing a relay coil.

5. A fire detection and alarm system for use in conventional electric distribution including a plurality of individual circuit systems comprising a plurality of normally open fire detector switches electrically connected by low resistance conductor means between a live and neutral line, a plurality of fuses, each of said fuses electrically connected in series with one of said lines in one of said plurality of circuits and adapted to blow upon a closure of one of said fire detector switches, a plurality of relay coils normally electrically connected across a pair of like potential points, means for charging the potential of one of said points upon the closure of a fire detector switch and the blowing of a fuse for energizing a relay coil, alarm means energizable by said relay coil, said alarm means including an alarm device and time-delay means for deferring the actuation of said alarm device until a predetermined interval after the energization of said alarm means.

6. A fire detection and alarm system for use in conventional electric distribution systems comprising at least one normally open fire detector switch, means carried by said switch for selectively closing and opening said switch in response to an increasing temperature, a step relay, said relay being selectively controlled by said switch, alarm means, said alarm means controlled by said switch and being actuated upon the completion of a predetermined number of steps of said relay.

7. The combination of claim 6 wherein said fire detector switch comprises a thermal spring, at least one container carried by said spring, a plurality of terminal pairs carried within said at least one container and a conductive fluid carried within said at least one container for selectively bridging pairs of said plurality of pairs of terminals.

8. The combination of claim 6 wherein said fire detector switch comprises a thermal spring, a container supported by said spring, said container internally constructed with adjacent ridges forming a plurality of separated pool pockets, a pair of electric terminals fixed in said pockets, a quantity of a conductive fluid adapted to form a pool in each of said pockets so as to bridge said terminals.

9. The combination of claim 6 wherein said fire detector switch comprises a thermal spring, a plurality of containers supported by said spring, each of said plurality of containers supported at a different angle relative to each other, a pair of electric terminals fixed in each of said containers, a quantity of conductive fluid carried in each container for bridging said terminals dependent on the angle of each container as varied by the thermal spring.

10. The combination of claim 6 wherein said fire detector switch comprises a thermal spring, a container supported by said spring, a pair of elongated parallel terminals internally carried on the inner surface of said container, one of said terminals being insulated for short lengths along the length thereof and a quantity of conductive fluid carried by said container for bridging said terminals.

11. A fire detection and alarm system for use in conventional electric distribution systems including a plurality of individual circuit systems comprising a plurality of normally open fire detector switches electrically connected between a live and neutral line, a plurality of fuses, each of said fuses electrically connected in series with one of said lines in one of said plurality of circuits and adapted to blow upon a closure of one of said fire detector switches, a plurality of relay coils normally electrically connected across a pair of like potential points, means for changing the potential of one of said points upon the closure of a fire detector switch and the blowing of a fuse for energizing a relay coil, means carried by each of said switches for selectively closing and opening said switch in response to an increasing temperature, a step relay, said relay being selectively controlled by said switches, said alarm means controlled by said switches and being actuated upon the completion of a predetermined number of steps of said relay.

12. A temperature responsive fire detector switch comprising a thermal spring, a container supported by said spring, a pair of elongated parallel terminals internally carried on the inner surface of said container, one of said terminals being insulated for short lengths along the length thereof and a quantity of conductive fluid carried by said container for bridging said terminals.

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