July 20, 1943. J. PETERSON ET AL 2,324,875

PROTECTIVE DEVICE

Filed July 17, 1940

Fig. 1.

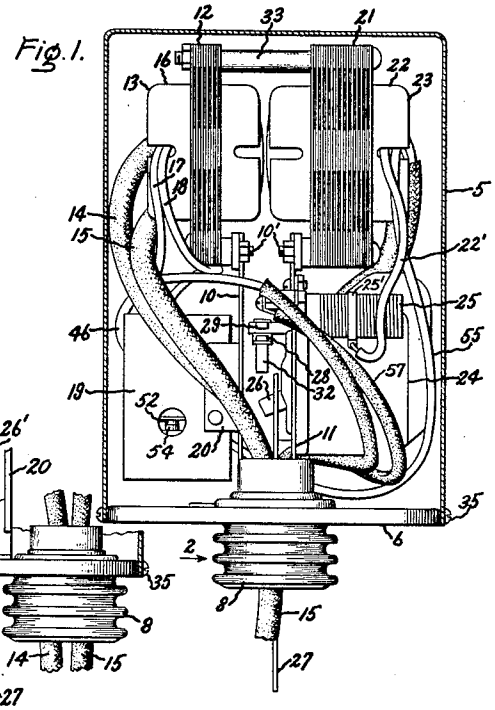


Fig. 2.

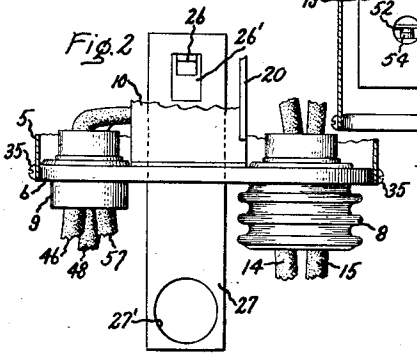
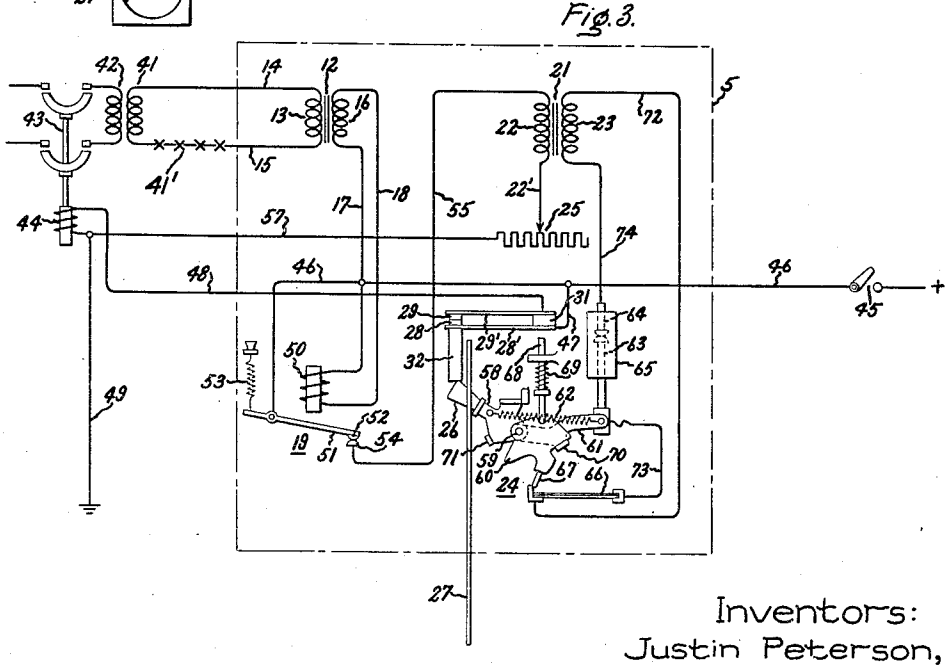


Fig. 3.



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Patented July 20, 1943

2,324,875

# UNITED STATES PATENT OFFICE

2,324,875

## PROTECTIVE DEVICE

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Application July 17, 1940, Serial No. 345,956

2 Claims. (Cl. 175—294)

Our invention relates to protective devices and more particularly to a device for effecting an opening of the main line switch of a series lighting circuit, in response to current interruptions in the circuit.

One object of our invention is to provide an improved construction and arrangement of apparatus for effecting an opening of the main line switch for a series lighting circuit in response to current interruptions caused by apparatus failures other than lamp failures.

For current interruptions in series lighting circuits caused by lamp failures it is desirable to maintain the main switch closed and to allow a short circuiting device, connected across the terminals of the lamp, i. e. the usual film cutout, to reestablish the circuit. For current interruptions due to other causes, however, such as the breaking of an overhead wire, for example, it is desirable to open the main line switch quickly and, if possible, before the wire falls to the ground. In view of these requirements, the time period between the actual interruption of current flow in a series lighting circuit and the instant at which the main switch should be opened, is critical. A time delay device for effecting the opening of such main line switch should operate accurately at the expiration of a predetermined time delay period. The delay period should be such that if the current interruption is caused by a lamp failure the film cutout will have time to operate to establish the circuit.

Furthermore, devices of this type are mounted outdoors, preferably near the line switch, and are exposed to outdoor ambient temperature throughout the seasons of the year. The time delay period, under which the switch operates, should remain constant, irrespective of the ambient temperature.

It is, therefore, another object of our invention to provide a protective device operable, throughout a wide range of ambient temperatures, to open a circuit within a predetermined constant time delay period.

For a better understanding of our invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing Fig. 1 is a cross sectional elevation of a protective device built in accordance with our invention; Fig. 2 is a fragmentary view of Fig. 1 looking in the direction of arrow 2 in Fig. 1; and Fig. 3 is a diagrammatic illustration of the elements of Fig. 1, together with their interconnecting circuits.

Referring to the drawing in detail Fig. 1 discloses a cross sectional elevation through a cylindrical casing 5 of sheet metal attached to a base 6. The base supports two porcelain bushings 8 and 9 (see Fig. 2) which extend through the base and are provided with openings through which conductors enter the casing to conduct current to elements of the device mounted within the casing. The base 6 has attached thereto brackets 10 and 11 upon which the elements of the protective device are mounted.

The elements mounted upon the brackets include a transformer 12. This transformer is provided with a winding 13, arranged to be connected in series with the lighting circuit which is to be protected, and is provided with leads 14 and 15 projecting through bushing 8. This same transformer is provided with a secondary winding 16 having leads 17 and 18 connected to a relay 19. The transformer 12 and the relay 19 are both mounted on the bracket 10, the transformer being supported at the upper end of the bracket by screws 10' projecting through the transformer core and through a suitable cross member welded to the upper end of the bracket, and the relay being attached to ears 20 projecting from the bracket directly below the transformer 12.

A second transformer 21 is mounted on the bracket 11. This transformer is provided with windings 22 and 23, the first of these windings being energized from an auxiliary source of power and the second being connected to supply heating current to a thermostatic switch 24. The thermostatic switch 24 is mounted on the bracket 11 below the transformer 21.

An adjustable resistor 25 is mounted on the bracket 11 beside the thermostatic switch in a suitable manner and is connected into the transformer winding 22 to regulate the current therein. This resistor is preferably a resistance wire wound upon a spool and is provided with a collar 25' which is slidable along the surface of the spool.

The thermostatic switch 24 is provided with a handle 26 which is movable to an upper position when the switch 24 is closed and is moved to a lower position when the switch 24 is open. At 27 is indicated a switch reset member having an elongated opening 26' through which switch handle 26 projects. The reset member 27 is supported by handle 26 and projects through the base 6, being freely movable through an opening in the base. This member follows the switch handle to its two positions and thereby provides an indication outside of the casing as to the position of the switch handle. The opening 26' (see Fig. 2) is elongated so that the switch handle 26 may move to its open position without a corresponding downward movement of the reset member 27. This is a necessary precaution because an accumulation of ice on the outside of the casing 5 and its base 6 which may occur in winter weather, may freeze the reset member in its upper closed

switch position. If it becomes necessary under those conditions for the switch 24 to operate, such operation can take place without a movement of the reset member 27. An opening 27' is provided in the lower end of the reset member so that it may readily be moved and thereby correspondingly move the switch handle 26 to either of its two positions.

A pair of contacts 28 and 29 are mounted in cooperative relationship with the thermostatic switch handle 26. In its movement to the upper and closed switch position the switch handle 26 moves the contact 28 to engage the cooperating contact 29, and thereby closes a circuit to a line-switch operating-coil. For convenience these contacts 28, 29 are supported upon the ends of resilient arms 28' and 29'. (See Fig. 3.) The other ends of these resilient contact arms are attached to a common block 31 which is in turn attached to the bracket 11. The contacts are so positioned in relation to the switch handle 26 that when the latter moves to its uppermost position it engages the end of a block 32 attached to the under side of the contact arm 28 and lifts the block and contact 28 into engagement with the contact 29.

The above-described apparatus is united into a rigid assembly by connecting the transformers 12 and 21 to each other by spacing bolts 33 and by suitably attaching the brackets 10 and 11 to the base 6. This latter is preferably done by welding the brackets to the base. The casing 5 is attached to the base 6 by screws 35.

The operation of the protective device may be understood by reference to Fig. 3. This figure illustrates diagrammatically each of the elements above described and the operating circuits, including a protected series lighting circuit. The circuit which is protected by the above-described device and into which the transformer winding 13 is directly connected by its leads 14 and 15, is supplied by a power supply transformer winding 41. The primary winding 42 of this power supply transformer is connected to a suitable power source by a double pole switch 43 held in closed position when its operating coil 44 is energized. This line switch 43 opens at the instant of deenergization of coil 44. The protected circuit includes series connected lamps 41' indicated diagrammatically. Each lamp may be provided with a film cutout (not shown) in the usual well known manner, to establish a circuit in shunt to the lamp terminals in case of lamp failure.

The coil 44 is normally energized through the contacts 28, 29 of the protective device. The circuit may be traced from a suitable source, indicated by a plus sign, which source may be of relatively low potential compared to the lighting circuit, through a switch 45 located outside of the protective device at any suitable location. The circuit for the coil 44 continues through a conductor 46, a conductor 47 to contact arm 28', contacts 28, 29, contact arm 29' and conductor 48 to the coil 44. The coil is grounded through a conductor 49. The circuit just traced is closed by the control switch 45 whenever it is desired to turn on the lights in the protected circuit. The circuit is opened by the movement of handle 26 effected by the operation of the thermostatic switch 24. The thermostatic switch is set to operate at the expiration of a predetermined time period, usually a fraction of a second, after the interruption of current in the lighting circuit.

The interruption of current in the lighting circuit is detected by the relay 19 which automatically initiates the timing operation at the switch 24. Relay 19 comprises an operating coil 50 connected to and energized by the transformer winding 16. The leads 17 and 18 are connected directly to the terminals of the relay coil 50 so that the relay coil is energized whenever there is current in the primary winding 13 and in the lighting circuit. It becomes deenergized at the interruption of current in the protected lighting circuit. The relay is provided with a moving arm 51 which carries a contact 52 and is biased by a spring 53 to move this contact into engagement with a cooperating contact 54. When the coil 50 is energized the arm 51 is raised to separate the contacts 52, 53 and thereby to hold open a circuit to the transformer winding 22. This circuit may be traced from the auxiliary source, switch 45, feed wire 46, to the relay arm 51, contacts 52, 54, conductor 55, transformer winding 22, conductor 22' (collar 25'), adjustable resistor 25, conductor 57, and through conductor 49 to ground. The conductor 46 is connected to the conductor 17 as indicated at their point of crossing to prevent a rise of the relay coil circuit potential above the auxiliary source potential. The elements of the protective device are thereby held at the comparatively low potential of the auxiliary source whereby insulation on the elements is relatively small and insulating oils are not needed. The resistor 25 is an adjustable resistor, preferably comprising a resistance wire wound on a porcelain spool. It is connected at one end to ground through the conductors 57 and 49, and is connected to the primary winding 22 by a conductor 22' and the collar 25'. This collar is movable along the resistor to regulate the resistance in this primary winding circuit of the transformer, thereby to determine the secondary heating current and to set the time interval of the thermal switch operation.

The thermal switch is a modified form of the switch described in detail in U. S. Patent 2,047,815, Atwood. It is a toggle switch having an operating lever 58 pivoted upon a pin 59, a trip member 60 pivoted upon the pin 59, and a contact-operating arm 61 also pivoted on the pin 59. A toggle spring 62 connected between the operating lever 58 and the contact arm 61 moves the contact arm 61 into an upward position so that a contact 63, mounted on the arm, engages a contact 64 within a shield 65 when the operating lever, and the handle 26 attached thereto, are moved to an upper position. The trip member is held in position by a thermostatic element 66, the free end of which engages a trigger 67 on the trip member 60. At normal temperatures the thermostatic element catches the trigger 67 and holds the member 60 stationary against the pressure of a pin 68 urged downwardly by a spring 69. When the thermostatic element is heated by current flowing through it, it flexes to release the trigger 67 and the pin 68 then moves the member 60 about its pivot pin 59 in a clockwise direction. The trip member, in turn, engages a tripping lug 70 on the arm 61 and carries the arm 61 in a clockwise direction, against the pull of the spring 62, to separate the contacts 63, 64. The switch 24 is reset by first moving the lever 58 counter-clockwise, the lever being provided with a projection 71 which engages the trip member 60. The trip member is so moved until the trigger 67 is engaged by the thermostatic element 66. The trip member 60 is then held in its normal position

by the thermostat. The lever 58 is thereafter moved clockwise to its uppermost position, the over-center spring 62 is moved past the pivot 59 and the arm 61 is thereby raised to close the circuit of contacts 63, 64.

The thermostatic element 66 is heated by current supplied by the transformer winding 23. The circuit may be traced from one terminal of the winding 23 through a conductor 72 to the thermostatic element 66, through the thermostatic element to a conductor 73, contacts 63, 64, and conductor 74 back to the winding. When the switch 24 is tripped by the thermostatic element 66, the contacts 63, 64 open the circuit to the thermostat and the handle 26 releases the contact 28 to open the circuit to the switch coil 44.

The timing of the thermostat operation is proportional to the heating current supplied by the transformer winding 23. The regulation of this current is obtained by adjusting the resistor 25 in the circuit of the primary winding 22. The thermostatic element 66 is arranged to operate at a relatively high temperature, at a temperature which is much higher than the average ambient temperature, being, for example, on the order of several hundred degrees Fahrenheit, a multiple of the average ambient temperature under which the device may be required to operate. The variations in outdoor ambient temperature, therefore, become a relatively small part of the operating temperature and have a correspondingly small influence upon the timing of the switch. The thermostatic element is also enclosed in a casing, thereby eliminating air currents and the accompanying heat loss. A single setting of the resistor 25 therefore suffices to maintain a constant time delay for all temperatures normally encountered throughout the seasons of a year in any one location.

In operation, the relay 19 becomes deenergized and immediately closes its contacts 52, 54 whenever a current interruption occurs in the series circuit. The closure of contacts 52, 54 initiates the timing of the thermostatic switch 24. If the current interruption is due to a lamp failure, the current is re-established by the short circuiting device connected across the terminals of the lamp before the thermostatic switch 24 operates and the relay again becomes energized, the time interval for this interruption being shorter than the time interval for which the switch 24 is set. The circuit to the main switch coil 44, therefore, remains closed at the contacts 29, 28 and no further operation of the protective device occurs.

In case the current interruption is due to causes other than lamp failure, the relay becomes deenergized, the contacts 52, 54 close and establish the circuit to the transformer winding 22 and current flows from the transformer winding 23 to the thermostatic element 66. If the contacts 52, 54 in this instance remain closed for the period for which the thermostatic element 66 is set to operate, the trigger 67 is released and consequently the switch 24 operates to separate the contacts 29, 28 thereby breaking the circuit to coil 44 and opening the switch 43. The circuit to coil 44 then remains open until an operator has determined the cause of the current failure and, after eliminating this cause, manually recloses the switch 24. The circuit to coil 44 is thereby closed at the contacts 29, 28 and assuming switch 45 to be closed, the coil 44 becomes energized and closes the main line switch 43. The relay coil 50 is then again energized and opens the circuit through contacts 52, 54 and the protective device is ready for another operation.

Advantages of this device over the devices hitherto used for similar purposes arise from the low potential at which the elements of this device are held through the use of the insulating transformer 12. Insulating oils which are necessary in high potential devices and also hamper contact operation in cold weather thereby become unnecessary.

Other advantages of this device arise from the use of the thermostatic element for effecting a time delay. A relatively high operating temperature, at which such devices may be adjusted to operate, reduces the influence of ambient temperatures to an amount that is inconsequential whereby the device operates at a substantially constant time delay period throughout the seasons of the year.

Still other advantages arise from the fact that this device may be reset only by manual operation of a thermostatic switch. In our device it is necessary to actuate the reset member 27 before it is possible to reclose the main line switch for the protective circuit. This element necessitates the attendance of an operator at the point of installation of the switch and thereby eliminates the danger of the switch being closed by a distant operator not familiar with the conditions at the switch.

What we claim as new and desire to secure by Letters Patent in the United States is:

1. In a protective system for a series lighting circuit, the combination of an actuating circuit including a pair of contacts operable to effect an opening of the supply switch to said circuit, means for operating said contacts comprising a time delay switch provided with a thermostatic element, said thermostatic element being operable at a temperature which is on the order of a multiple of the average ambient temperature under which said thermostatic element is caused to operate, and means for conducting heating current to said thermostat responsive to an interruption of current in said protected circuit to effect an operation of said time delay switch.

2. In a protective system for a series lighting circuit, the combination of an actuating circuit including a pair of contacts operable to effect a disconnection of said lighting circuit from its current source, a time delay device arranged to operate said contacts provided with means responsive to an interruption of current in the protected circuit, a thermostatic element, means responsive to an interruption of current in said protected circuit for establishing a circuit for a heating current to heat said thermostatic element to its operating temperature, and means in said circuit for adjusting said heating current to obtain a predetermined timing for the operation of said thermostatic element at an average ambient temperature, said operating temperature being on the order of a multiple of said average ambient temperature whereby the effect of a variation in said ambient temperature upon the timing of said thermostatic element becomes negligible.

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