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FAULTY CIRCUIT ALARM

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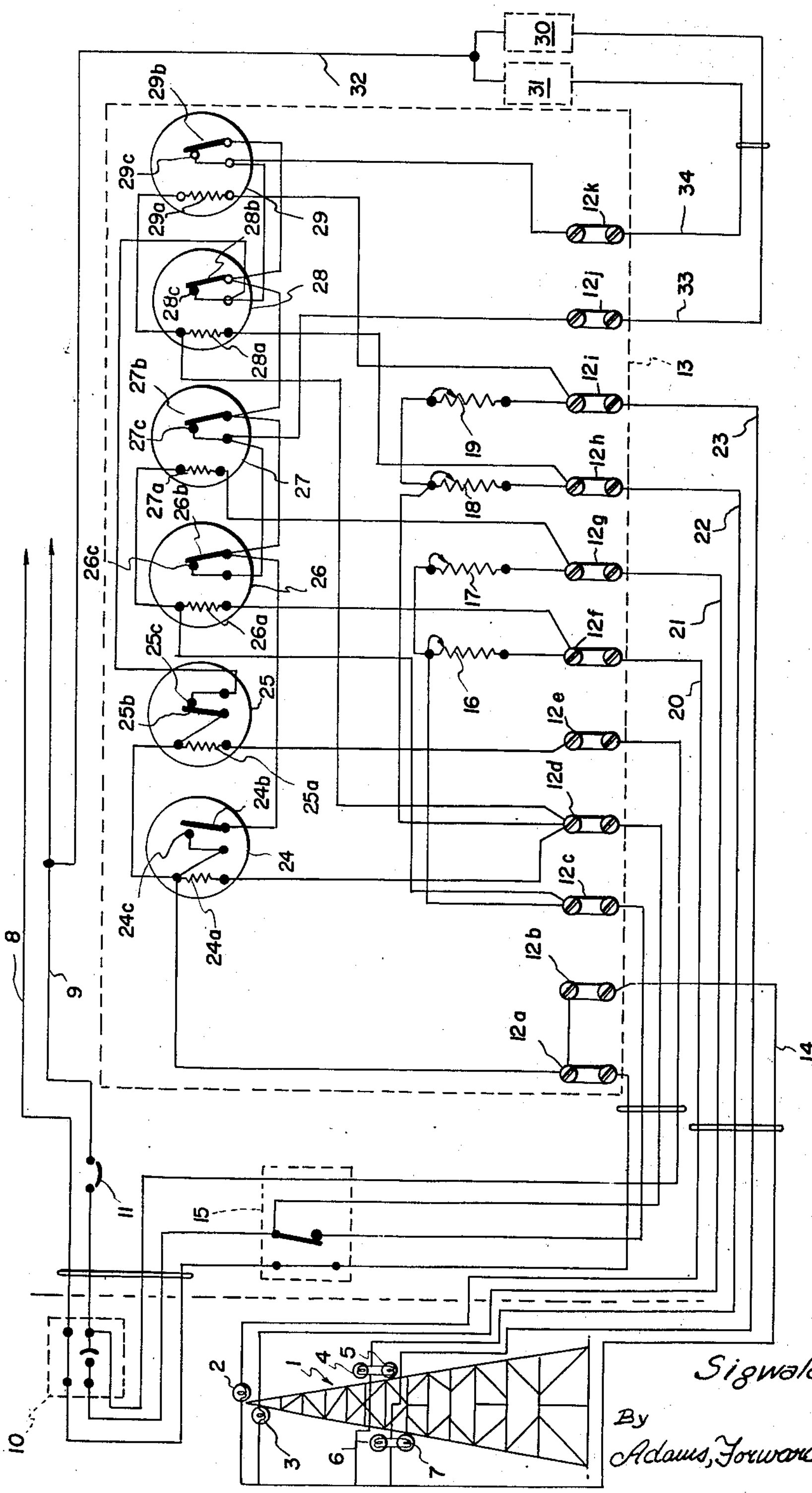

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FAULTY CIRCUIT ALARM

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My invention relates to alarming devices and more particularly provides a system for actuating an alarm to indicate failure of automatically intermittently or periodically actuated remotely located electrical equipment.

The failure of automatically operated illuminating lamps such as beacon and warning lamps used on radio or other towers requires in many instances the production of an alarm signal to indicate such failure to an attendant located at some remote point. It is often desirable where different groups of lights are employed at a given location to produce an alarm signal indicating the failure as occurring in one particular group of lights or to indicate failure of the immediate power circuit serving the lights in order that the remotely located attendant can be properly informed as to the nature of the equipment which has failed and thus indicate the necessary replacement parts as well as the urgency of the failure.

I have found that in automatically and intermittently or periodically operated remote equipment automatic alarm signal operation can be obtained by a system utilizing delayed action, thermally operated, circuit controlling devices wherein a normally open first thermal delay relay is actuated to close an independent alarm circuit in response to application of operating potentials to the remotely located electrical system, and wherein a normally closed second thermal delay relay, having a shorter period of actuation than the first relay device, is actuated in response to the flow of current to the remotely located electrically operated device to open the independent alarm circuit by connection of its switch contacts in series with the switch contacts of the first relay device.

I am aware that heretofore thermally sensitive circuit breaking devices have been utilized to detect lamp failure at remotely located lamp installations by positioning such devices in the proximity of the lamps to be monitored to cause the devices to operate in response to the presence or absence of heat radiated by the lamps. Such thermally sensitive contacting devices are particularly subject to the disadvantage that their location in the proximity of the lamp to be monitored often makes them relatively inaccessible for servicing and requires an additional electric lead to be wired in with power lines to the lamp. Such contactors are also limited to usage in detection of failure of remotely located electrical equipment which operate at relatively high temperatures, such as lamps, and cannot be used to detect failure of relatively cold running electrical equipment.

It is a particular object of my invention to provide a detecting and alarm circuit actuating device for remotely located electrical devices which is not dependent on the heat radiated by the electrical device monitored and which can therefore be remotely located from the device monitored.

The system of my invention is particularly useful in the case of radio beacon and side lamps which are actuated by a photo-electric unit at nighttime and which remain unactuated during daytime. The use of a normally open slower operating delayed action alarm circuit controlling device operating in response to the closure of the power circuit by the photo-electric element in series with a normally closed faster operating delayed action alarm circuit controlling device operating in response to the flow of current to the beacon and side lamps prevents accidental actuation of the alarm circuit as the photo-electric element closes the power circuit connection, and yet permits the alarm circuit to be used upon lamp failure. Moreover, in radio tower beacon lamps where a flasher unit is utilized, the faster acting thermally operated delay relay can be selected to have a period of operative delay exceeding the period of operation of the flasher unit and thus operate independently of such relatively rapid periodic actuation and deactuation of the remotely located warning lamps.

The system of my invention also contemplates a plurality of the faster acting thermal operated delay relays operated in parallel banks connected to control a plurality of alarm circuits all having a common ground circuit connected in a series through the slower acting thermally operated delay relay. I can thereby provide separate alarm circuits as required, for example, for different groups of lamps, or lamps having different wattages or different operating characteristics.

I have found, furthermore, that it is particularly desirable to connect the alarm circuits through a common ground to the neutral line in the power circuit leading to the remotely located device, placing all control equipment for the remote installation in the connection to the hot power line. Failure of overload circuit breaker devices or fuses in the hot lead to the remotely located device can thus also be detected and indicated over the alarm circuits. Since the slower acting relay is normally open, indication of a circuit breaker or fuse failure is obtained by paralleling the slower relay switch contacts by the switch contacts of a normally closed faster acting thermally operated delay relay, which upon actuation closes the alarm circuit, but which is operatively connected to the incoming power line and hence remains open except upon failure of overload circuit breakers, or upon power line failure.

The drawing schematically illustrates the application of the alarm system of my invention to an automatically operated, remotely located, radio tower having flashing beacon and steady side warning lamps.

In the accompanying drawing, the reference number **1** indicates a radio tower having a pair of beacon lamps **2** and **3** and having four side lamps **4**, **5**, **6**, and **7**. Electrical power lines **8** and **9** supply power to the installation, line **8** being the neutral line.

A photo-electric unit, diagrammatically shown in the drawing and indicated by the reference number **10**, is utilized to actuate the beacon and side lamps of tower during the nighttime by closing a circuit controlling device connecting the beacon and side lamps to power line **9** through an over-load circuit breaker **11**.

Connection to neutral line **8** at the installation is to post **12*a*** of an eleven post terminal strip located in cabinet **13** conveniently positioned near the base of the tower. Terminal post **12*b*** is connected internally to terminal post **12*a*** and is connected externally as a common ground lead to all six beacon lamps by line **14**.

Connection between hot power line **9** and terminal post **12*c*** in cabinet **13** is made through photo-electric unit **10** as indicated above and through an automatic flasher unit, also diagrammatically illustrated in the drawing, and indicated by the reference number **15**. Flasher unit **15** is designed to open and close the connection between photo-tube unit **10** and terminal post **12*c*** at a relatively rapid periodic rate of, for example, one cycle every five seconds. A second connection from photo-unit **10**, bridging flasher unit **15**, is brought to terminal post **12*d*** in cabinet 13 and a connection from circuit breaker 11 is brought directly to terminal post 12*e* in cabinet 13.

Terminal post 12*c*, which is externally connected through flasher unit 15, is connected internally to terminal post 12*f* through an adjustable resistor 16, and internally connected to terminal post 12*g* through an adjustable resistor 17. Terminal post 12*d*, which is externally connected to photo-unit 10 and bridges flasher unit 15, is internally connected to terminal post 12*h* through adjustable resistor 18 and is internally connected to terminal post 12*i* through adjustable resistor 19.

As before noted each of beacon lamps 2 and 3 and each of side lamps 4, 5, 6 and 7 is connected to terminal post 12*b* through a common ground lead 14. The hot connection 20 to beacon lamp 2 is made to terminal post 12*f*. The hot lead connection 21 to beacon lamp 3 is made to terminal post 12*g*. Side lamps 4 and 5 are connected in parallel and are provided with a hot lead connection 22 to terminal post 12*h*. Similarly, side lamps 6 and 7 are connected in parallel to terminal element 12*i* through hot lead connection 23.

The preceding description of the tower lamp powering circuits is conventional with the exception of the inclusion of adjustable resistors 16, 17, 18 and 19 located in series with hot leads 20, 21, 22 and 23 to the beacon and side lamps. In the device shown in the drawing, I employ six thermally operated delay relays, e. g., circuit controlling devices having a heating filament which upon energization causes actuation of a bi-metallic switch wherein operation of the bimetallic switch member occurs with a certain time delay after energization of the heating filament. Such time delays are accurately calculable, and thermally operated delay relays are commercially available in a variety of filament voltages and delay periods.

In the system shown in the drawing I employ a first thermally operated delay relay 24 having a filament 24A designed for energization by a voltage equal to that of the voltage on power lines 8 and 9. Relay 24 is provided with a normally open bi-metallic contact member 24*b* which closes with contact member 24*c* 120 seconds after energization of filament 24*a* in the illustrated case. Relay 24 is commercially available under the designation 115NO120 for 110 to 120 volts filament voltage.

The second thermally operated delay relay 25 has a filament 25*a* with a similar voltage rating to filament 24*a*. Relay 25 has a bi-metallic movable contact member 25*b* which is normally closed with fixed contact 25*c* but which opens after energization of filament 25*a* by the proper voltage after a delay, in the illustrated case, of approximately 30 seconds. For 110 to 120 volts service relay 25 is commonly available under the designation 115C30.

Four additional thermally operated delay relays are employed. These are designated by the reference numerals 26, 27, 28 and 29. These relays are identical and have heating filaments 26*a*, 27*a*, 28*a* and 29*a*, respectively, which are designed for a relatively low applied voltage, in the illustrated case about 2½ volts. Each of relays 26, 27, 28 and 29 has a movable bi-metallic contact member 26*b*, 27*b*, 28*b* and 29*b*, respectively, which is normally closed with a fixed contact member 26*c*, 27*c*, 28*c* and 29*c*, respectively, and which opens with a delay of 30 seconds after filament energization. Relays 26, 27, 28 and 29 are commonly available under the designation of 2C30.

In the illustrated case I employ two alarm circuits which are utilized independently to operate alarm devices 30 and 31 which may be located at some remote point such as at an attended control station or which are utilized to transmit a radio signal to such an attended control station. Alarm devices 30 and 31 are connected to hot power line 9 through lead 32 and are connected to terminal posts 12*j* and 12*k* in cabinet 13 through independent connections 33 and 34, respectively.

The internal connections in cabinet 13 between the various terminal posts and relays 24, 25, 26, 27, 28, and 29 are as follows.

Filament 24*a* is connected between posts 12*a* and 12*d*, and filament 25*a* is connected between posts 12*a* and 12*e*. Thus filament 24*a* is energized upon closure of the circuit through photo-unit 10 and filament 25*a* is energized as long as power is supplied through lines 8 and 9 and circuit breaker 11 is closed. Filament 26*a* is connected between terminal posts 12*c* and 12*f* and thus is energized by a voltage drop produced across adjustable resistor 16. Similarly, filament 27*a* is connected between terminal posts 12*c* and 12*g* for energization by a voltage drop across adjustable resistor 17; filament 28*a* is connected between terminal posts 12*d* and 12*h* for energization by a voltage drop produced across adjustable resistor 18; and filament 29*a* is connected between terminal posts 12*d* and 12*i* for energization by a voltage drop produced across adjustable resistor 19. Alarm device 30 is connected to neutral line 8 by a connection between terminal post 12*a* and terminal post 12*j* in series with switch contacts 24*b* and 24*c* of relay 24 and in series with parallel switch contacts 26*b* and 26*c* and switch contacts 27*b* and 27*c* of relays 26 and 27. Similarly, alarm device 31 is connected to neutral line 8 by internal connection between terminal post 12*a* and terminal post 12*k* which includes in series switch contacts 24*b* and 24*c* of relay 24 and in series the parallel combination of switch contacts 28*b* and 28*c* and switch contacts 29*b* and 29*c* of relays 28 and 29. Switch contacts 25*b* and 25*c* of relay 25 are connected between terminal post 12*a* and terminal post 12*k*.

In order to illustrate the operation of the device shown in the drawing assume power is continuously supplied to leads 8 and 9 and circuit breaker 11 is properly closed. Relay 25 is thus actuated with switch contacts 25*b* and 25*c* held open. As daylight fails, photo-unit 10 closes the main circuits to beacon lamps 2 and 3 through flasher unit 15 and the main circuits to side lamps 4, 5, 6 and 7, thus lighting all six lamps on tower 1.

As photo-unit 10 operates, filament 24*a* is energized and contact 24*b* begins to move toward contact 24*c*. Closing these contacts requires a period of approximately two minutes. In the meantime, filaments 26*a*, 27*a*, 28*a* and 29*a* are also energized by the voltage drop produced in resistors 16, 17, 18 and 19, respectively, by the flow of current therethrough to the various lamps on tower 1. The consequent actuation of relays 26, 27, 28 and 29 causes bi-metallic contact members 26*b*, 27*b*, 28*b* and 29*b*, respectively, to part from fixed contact members 26*c*, 27*c*, 28*c* and 29*c*, respectively, within a period of relatively short duration, i. e. 30 seconds, thus opening alarm circuit 33 (through relays 26 and 27) and alarm circuit 34 (through relays 28 and 29) so that, by the time relay 24 has closed, the alarm circuits cannot be actuated by such closure and thus a false alarm is not transmitted during the warming up period of relays 26, 27, 28 and 29. It should be noted that resistors 16, 17, 18 and 19 are adjusted to provide the required resistance for proper energization of filaments 26*a*, 27*a*, 28*a* and 29*a*, respectively.

Failure of either beacon lamp 2 or 3 or its associated connection 20 or 21 will eliminate the voltage drop produced in resistor 16 or 17, respectively, and consequently cause de-energization of either relay 26 or 27, depending upon which beacon lamp has failed. Since relay 24 is closed such deactuation of either relay 26 or 27 will energize alarm circuit 33 and thus produce an alarm at device 30 which will inform the remotely stationed attendant that one of the beacon lamps has failed.

Similarly, failure of one of the side lamps 4 or 5 or of one of the side lamps 6 or 7 will de-energize either relay 28 or 29 and thus close alarm circuit 34 to cause alarm device 31 to operate.

If an overload occurs causing circuit breaker 11 to open, all the relays will become de-energized and alarm circuit **34** will be energized through the closure of the switch contacts in relay **25**, consequently causing alarm device **31** to operate even though the switch contacts in relay **24** open, breaking the alarm circuits through relays **26, 27, 28** and **29**.

From the foregoing discussion it will be seen that the device illustrated in the drawing is readily adaptable to other types of remotely located electrical devices which are automatically and intermittently or periodically actuated and is further capable of providing the necessary alarm signals to inform a remotely stationed attendant of such failure. At the same time the device is provided with necessary precautions, to prevent accidental alarms during warm up and is also provided with suitable circuitry to provide actuation of an alarming device in the event the power applied to the remote location should fail.

I claim:

1. In a radio tower having a beacon lamp, a powering circuit, and a photo-electric actuating device and a flashing unit connected in series with said beacon lamp in said powering circuit, the improvement which comprises a normally open thermally operated delayed action circuit controlling device, means energizing said normally open device in response to closure of said photo-electric device to close said normally open device, a normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said first delayed action device, means located apart from said lamp energizing said normally closed device in response to the flow of current in said powering circuit to open said normally closed device, and an alarm circuit including an alarming device connected in series with said delayed action circuit controlling devices.

2. In a radio tower having a beacon lamp, a powering circuit and a photo-electric actuating device and a flashing unit connected in series with said beacon lamp in said powering circuit, the improvement which comprises a normally open thermally operated delayed action circuit controlling device, means energizing said normally open device in response to closure of said photo-electric device to close said normally open device, a normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said first delayed action device, means located apart from said lamp energizing said normally closed device in response to the flow of current in said powering circuit to open said normally closed device, an alarm circuit including an alarming device connected in series with said delayed action circuit controlling devices, a second normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said normally open delayed action device, and means energizing said second normally closed device in response to energization of said powering circuit to open said second normally closed device, said second normally closed device being connected in said alarm circuit paralleling said normally open delayed action device and said first normally closed delayed action device.

3. In a remotely located installation including an electrically actuated device, a powering circuit therefor, and an automatic circuit controlling device connected in series with said electrically actuated device in said powering circuit, an alarm system for detecting and indicating faulty power circuit closure which comprises a normally open thermally operated delayed action circuit controlling device, means energizing said normally open device in response to closure of said automatic circuit controlling device to close said normally open device, a normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said normally open delayed action device, means located apart from said remotely located electrically actuated device energizing said normally closed device in response to the flow of current in said powering circuit to open said normally closed device and an alarm circuit including an alarming device connected in series with said delayed action circuit controlling devices.

4. In a remotely located installation including an electrically actuated device, a powering circuit therefor, and a first automatic circuit controlling device and a second automatic circuit controlling device connected in series with said electrically actuated device in said powering circuit, said second automatic circuit controlling device being intermittently or periodically operable to close said powering circuit and said first controlling device being operable to close said powering circuit in response to a varying external condition, an alarm system for detecting and indicating faulty power circuit closure which comprises a normally open thermally operated delayed action circuit controlling device, means energizing said normally open device in response to closure of said first automatic circuit controlling device to close said normally open device, a first normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said normally open delayed action device, means located apart from said remotely located electrically actuated device energizing said normally closed device in response to the flow of current in said powering circuit to open said normally closed device, an alarm circuit including an alarming device connected in series with said delayed action circuit controlling devices, a second normally closed thermally operated delayed action circuit controlling device having a delay period of shorter duration than said normally open delayed action device, and means energizing said second normally closed device in response to energization of said power circuit to open said second normally closed device, said second normally closed device being connected in said alarm circuit paralleling said normally open delayed action device and said first normally closed delayed action device.

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