Feb. 1, 1955 W. M. ALTHERR 2,701,325

CONTROL FOR RELAY CIRCUITS

Filed April 20, 1951 2 Sheets-Sheet 1

FIG. 1. 6:00 A.M. TO 5:59 P.M.

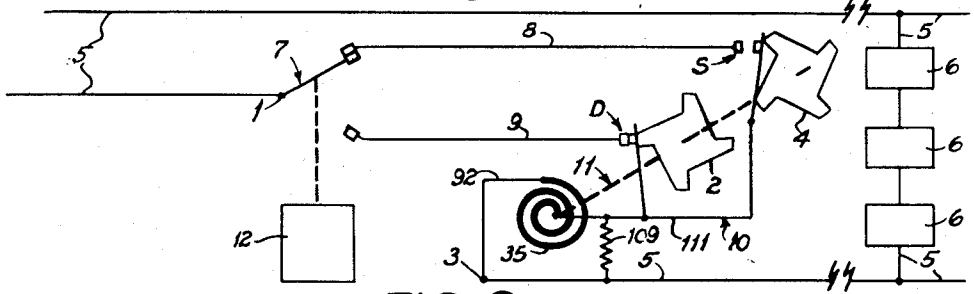


FIG. 2. 5:59 P.M. TO 6:00 P.M.

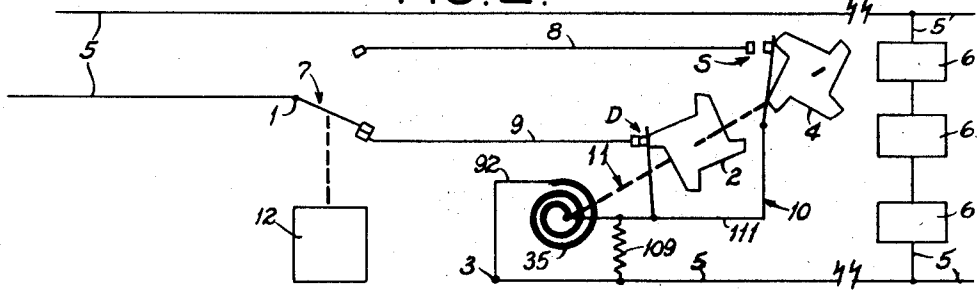


FIG. 3. 6:00 P.M. TO 5:59 A.M.

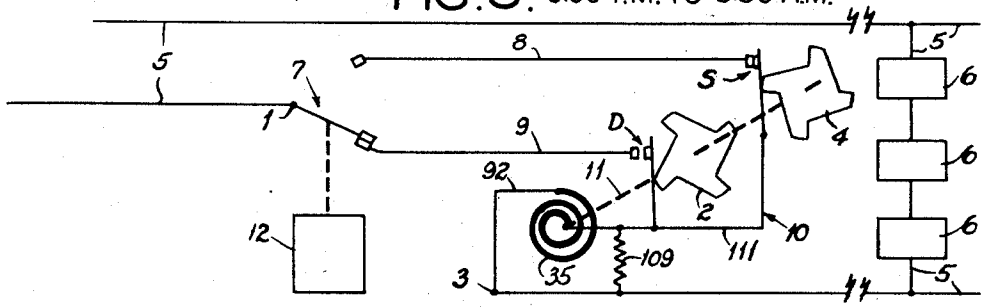
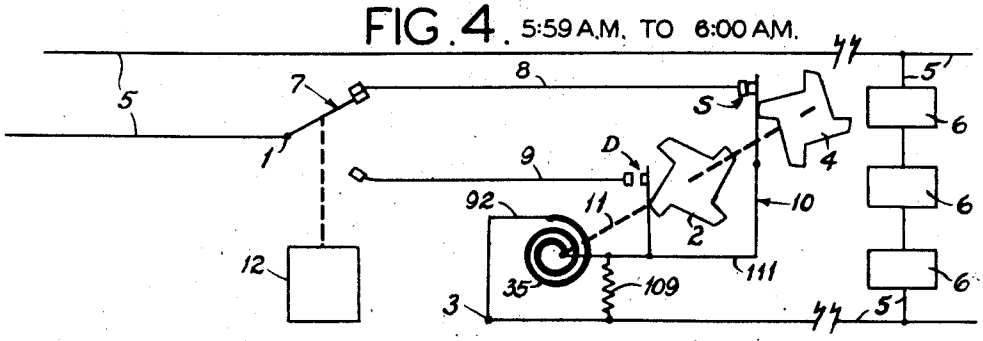


FIG. 4. 5:59 A.M. TO 6:00 A.M.



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FIG. 5.

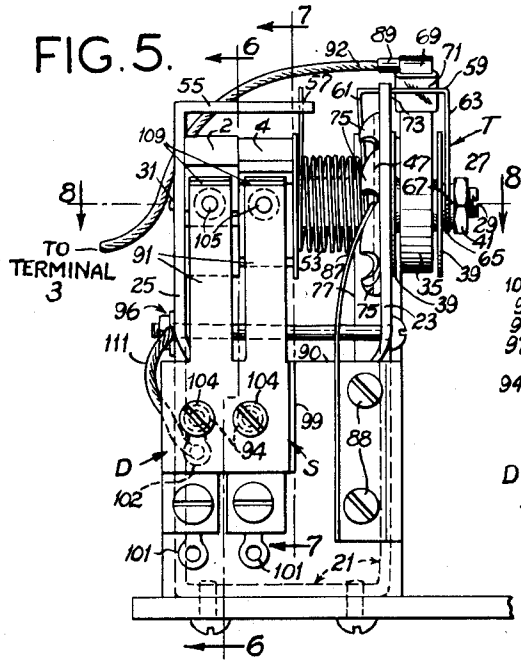


FIG. 6.

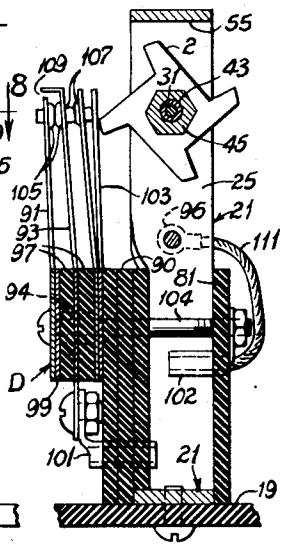


FIG. 7

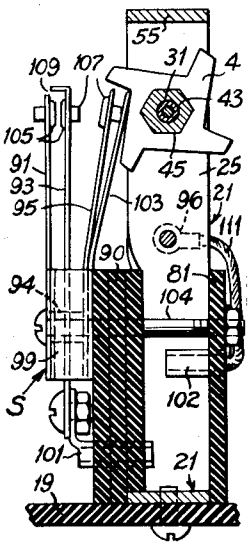


FIG. 10.

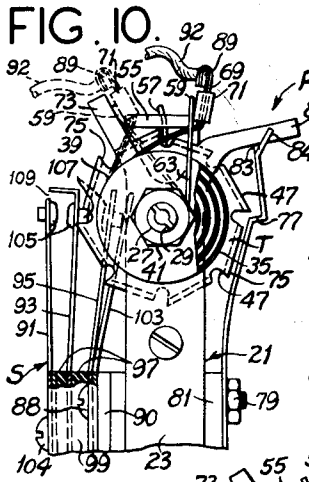


FIG. 11.

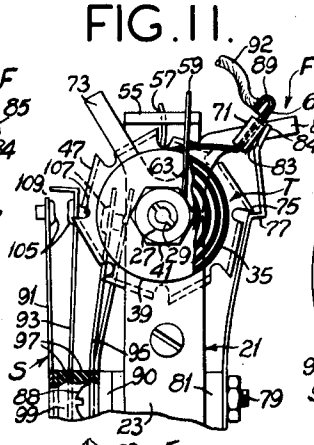


FIG. 8.

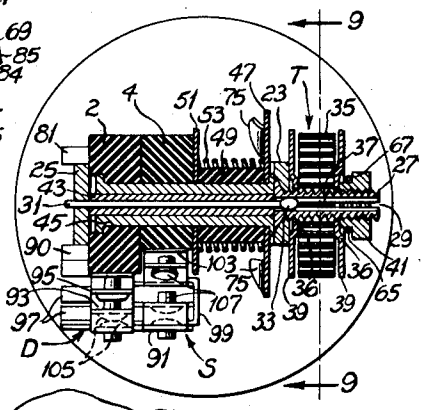
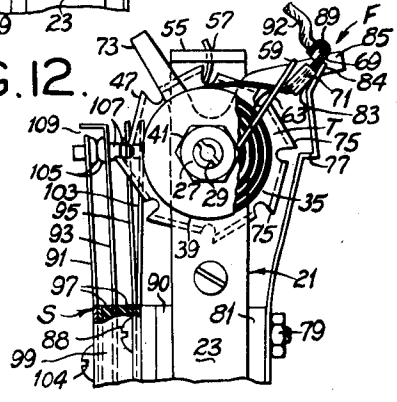


FIG. 12.



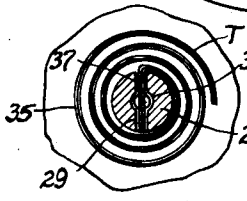


FIG. 9.

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United States Patent Office

2,701,325

Patented Feb. 1, 1955

2,701,325

CONTROL FOR RELAY CIRCUITS

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Application April 20, 1951, Serial No. 222,116

2 Claims. (Cl. 317—132)

This invention relates to controls for relay circuits, and more particularly to such controls as are used in street lighting systems to operate relays to turn street lamps on and off.

The invention is particularly adapted for use in a street lighting circuit such as disclosed in my copending application entitled Circuit-Relay Apparatus, Serial No. 221,229, filed April 16, 1951. In said copending application I disclose a street lighting system wherein thermostatic relays each controlling a group of street lamps are in turn controlled by a control switch which is operated to transmit a pulse of current of such duration as to insure that all of the relays operate to turn the groups of street lamps controlled thereby on or off, as the case may be. This invention pertains to a control which fulfills the function of this control switch in a most reliable manner, and which may be economically manufactured. As herein illustrated, the control of this invention utilizes certain features of construction of the relay itself shown in said copending application, making it economical for the manufacturer to provide both said relays and controls therefor, inasmuch as they have interchangeable parts.

In general, it is to be noted that the control of this invention is applicable to any relay circuit, whether a street lighting system relay circuit or otherwise, where it is desired to effect operation of the relays in the relay circuit at periodic intervals by transmitting a pulse of current of limited duration through the relay circuit to operate the relays. As related to the control of street lighting systems, the control of this invention is particularly adapted to transmit a pulse of current at the time for turning on the lamps, this pulse operating the relays to effect closure of the lamp circuits, and to transmit a pulse of current at the time for turning off the lamps, this pulse operating the relays to effect opening of the lamp circuits.

In general, a control constructed in accordance with my invention comprises first and second terminals for connection in a relay circuit. A first double-throw switch is provided for alternately effecting connection of the first terminal to one or the other of two branches between the terminals. A second double-throw switch is provided for alternately effecting connection of the said branches to the second terminal. An electrically actuated time-delay means is provided for effecting time-delayed operation of the second double-throw switch whenever the first and second double-throw switches are in position for flow of current between the terminals. With this arrangement, assuming that the switches are in position for flow of current between the terminals, the electrically actuated means will be energized and after a time delay will operate the second double-throw switch to break the established circuit and thereby deenergize the electrically actuated means. Thus, a pulse of current is transmitted prior to the operation of the second double-throw switch, this pulse being of a duration determined by the time-delay characteristic of the electrically actuated means. Then, the first double-throw switch remains in the position which it had to begin with. Subsequently, upon throwing of the first double-throw switch to its alternate position, the circuit through the electrically actuated means is again closed, and another pulse of current of the said duration is transmitted, this pulse continuing until the electrically actuated means operates the second double-throw switch. Other features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of which will be indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

Figs. 1 to 4 are circuit diagrams illustrating the basic principles of the control of this invention, and showing parts thereof in different operating conditions;

Fig. 5 is a front elevation of a unit incorporating the second of the above-mentioned double-throw switches and the electrically actuated time-delay means therefor;

Fig. 6 is a vertical cross section taken on line **6**—**6** of Fig. 5;

Fig. 7 is a vertical cross section taken on line **7**—**7** of Fig. 5;

Fig. 8 is a horizontal cross section taken on line **8**—**8** of Fig. 5;

Fig. 9 is a vertical cross section taken on line **9**—**9** of Fig. 8;

Fig. 10 is a fragmentary side elevation as viewed from the right side of Fig. 5 illustrating in solid lines an intermediate position of a thermostatic element, and indicating in dotted lines an initial position of said thermostatic element; and,

Figs. 11 and 12 are views similar to Fig. 10 illustrating moved positions of parts.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

First referring to Figs. 1 to 4, which illustrate the basic principles of the control of this invention, there is shown at **1** a first terminal and at **3** a second terminal. These terminals are for connection of the control in a relay circuit designated **5**. Several series-connected relays in this relay circuit are shown at **6**, and it will be understood that as many relays as desired may be connected in this circuit for control. Here it may be said that the terminals **1** and **3** correspond to the terminals of the switch C shown in my aforesaid copending application, and that the connection of relays and lamps may be made in the same manner as therein illustrated.

At **7** is shown a first double-throw switch for alternately effecting connection of the terminal **1** to one or the other of two branches **8** and **9** between the terminals **1** and **3**. At **10** is indicated a second switch, which is basically a double-throw switch, for alternately effecting connection of the branches **8** and **9** to the terminal **3**. At **11** is generally indicated an electrically actuated time-delay means for operating the second double-throw switch **10** whenever the switches **7** and **10** are in position for flow of current between the terminals **1** and **3**. This means will ultimately be more particularly described. It suffices to say at this point that the time-delay means comprises a spiral bimetallic electrically conductive thermostatic element **35** which controls the operation of two cams **2** and **4** which actuate sets of contacts D and S of the switch **10**. The thermostatic element **35** is connected so that current flows therethrough whenever the switches **7** and **10** are positioned for flow of current between the terminals **1** and **3**. There are two such positions possible, these being illustrated in Figs. 2 and 4. Two other positions, in which no current can flow between the terminals **1** and **3**, are illustrated in Figs. 1 and 3. When current flows through the thermostatic element **35**, it heats up and, after a time delay, effects rotation of the cams to open those contacts of the switch **10** which were closed, and to close those which were open.

At **12** is diagrammatically shown a device for effecting operation of the first double-throw switch **9**. This might be a conventional timer, or, particularly in the case of a street lighting system, a photocell-controlled device. For example, in the case of a street lighting system in which the lamps are to be turned on at 6:00 P. M. and turned off at 6:00 A. M., and assuming that a pulse of one-minute duration is desired to operate the relays, the device **12** would be one that operates to throw the switch **7** from whichever position it was in at 5:59 P. M. to the opposite position, and to throw it back at 5:59 A. M. As a matter of fact, the switch **7** might even be manually thrown at these times, if desired.

Figs. 1 to 4 illustrate the operation as related to a setup for throwing the switch **7** at the above noted times, and for obtaining a relay-operating pulse of one minute duration. Fig. 1 illustrates the status of the control during the time from 6:00 A. M. to 5:59 P. M. Contacts D are closed and contacts S are open. During this time the street lamps are off. The switch **7** is in position effecting a connection from the terminal **1** to the branch **8**, but branch **8** is open at the contacts S. Consequently there is no flow of current between the terminals **1** and **3**.

At 5:59 P. M. the switch **7** is thrown to the Fig. 2 position in which it connects branch **9** to the terminal **1**. Inasmuch as contacts D of the second double-throw switch **10** are closed at this time, current flows between the terminals **1** and **3** and through the thermostatic element **35** and energizes the relay **6** to turn on the street lamps. After a time delay of one minute, assuming that the thermostatic element is such as to give this time delay, the switch **10** is thrown so that contacts D open and contacts S close. This status is illustrated in Fig. 3. With the switch **7** remaining in position connecting terminal **1** to branch **9**, no current flows between the terminals **1** and **3**.

The Fig. 3 condition is maintained until 5:59 A. M. At 5:59 A. M., the switch **7** is thrown back to the position wherein it connects terminal **1** to the branch **8**. Inasmuch as the contacts S are now closed, current flows from the terminal **1** through the thermostatic element **35** to the terminal **3**, and hence the relay circuit **5** is energized to operate the relay **6** to turn off the street lamps. This flow of current is maintained for one minute, at which time the thermostatic element **35** is heated sufficiently to effect operation of the cams **2** and **4** to open the contacts S and close the contacts D. This brings the control back to the condition illustrated in Fig. 1. The entire operation is repeated every twenty-four hours.

Figs. 5–12 illustrate the details of a form of unit which I have used incorporating the double-throw switch **10** and the electrical-actuated time-delay means **11**. As shown therein, this unit includes an insulating base **19** on which is supported a generally U-shaped conductive frame **21** having legs **23** and **25** and an upper arm **55**. Extending from the leg **23** is a conductive hollow threaded stud **27** which is axially slotted as shown at **29**. This stud accepts a pintle **31** which forms a bearing support between the legs **23** and **25**. This pintle is flattened out as at **33** to key into the slot **29**. Around the stud **27** is located the spiral bimetallic conductive thermostatic element **35** which has a central tongue **37** keyed into the slot **29**. This thermostatic element **35** is flanked by two porcelain enameled protective washers **39** which have both heat-resisting and insulating properties. A lock nut **41**, threaded to the stud **27**, serves to clamp the central part of element **35** between offset central portions **36** of the washers. The resulting reactions hold the stud **27** in place. Its angular position may be adjusted by loosening the lock nut **41**, and turning **27** by means of a screw driver in slot **29** and then again tightening the lock nut. This adjusts the angular position of the center of the thermostatic element **35** and hence its operating characteristics, as will appear. Tongue **37** in slot **29** axially positions the pintle **31**, as shown in Fig. 8. Thus the thermostatic element **35** is centrally anchored and in conductive relation to the frame **21**. A terminal for the frame is provided at **96**.

Around the pintle **31** is located a sleeve **43**. This sleeve is located within a circular hole in a rotary camshaft **45** which is in the form of a polygonal bushing. The camshaft **45** carries in keyed relation (by reason of its polygonal form; Figs. 6 and 7) an eight-toothed ratchet **47**, an insulating spacer **49**, an insulating washer **51**, and the cams **2** and **4**. The ends of the camshaft **45** are upset, as shown, to hold together as a unitary rotary assembly the parts **2**, **4** and **47**. Cams **2** and **4** are composed of insulating material; ratchet **47** is not, although it might be.

Wound around the spacer **49** is a helical spring **53** which has one end anchored in the extension **55** from the leg **25**, as indicated at **57** in Fig. 5. The other end of this spring is formed as a bail **59** having a leg **61** and a leg **63**. The inner end of leg **63** forms a loose wrap **65** around a groove **67** in the nut **41**. Thus the spring at one end is anchored at **57** but the wrap **65** at the other end is rotary in the groove **67**.

The thermostatic element **35**, except at its anchored central position, is free and spirals to its outer end **69**

where it is provided with an insulating collar **71** engageable with the bail **59**. When the thermostatic element **35** cools, it tends to unwind in counterclockwise direction as viewed in Figs. 10–12, thus forcing the bail **59** toward a stop **73** which forms an extension from the leg **23**. This increases the tension in the spring **53**, which has been prewound prior to anchoring at **57**, so as to bias its bail in clockwise direction as viewed in Figs. 10–12. When the thermostatic element **35** heats, it tends to wind in clockwise direction as viewed in Figs. 10–12 and the tensioned spring **53** follows it, as illustrated in Fig. 10. After following to a certain point, the leg **61** of the bail **59** is caught behind one of the laterally directed teeth **75** of the ratchet **47**. At this time the ratchet is prevented from moving clockwise because of engagement by another one of its teeth **75** with a spring pawl **77**. This spring pawl is anchored at its lower end, as shown at **79**, to an insulating block **81**. The pawl **77** biases counterclockwise, the motion being limited by engagement of its upper end **83** with a second stop **85** extending from the leg **23**. This stop is for the purpose of allowing only enough counterclockwise movement of pawl **77** to latch under a tooth **75** without acting as a friction brake on the ratchet **47**. Upon continued heating of the thermostatic element **35** it moves from the Fig. 11 to the Fig. 12 position, leaving behind the bail **59**, which then applies the tension of spring **53** to ratchet **47**, but the ratchet is held against clockwise movement by the pawl **77**. After a period of further heating the insulating collar **71** engages an offset end portion **84** of the pawl **77**. This disengages the pawl **77** from the ratchet **47**, and the bail **59** of the spring **53** advances the ratchet one-eighth turn with a snap action (compare Figs. 11 and 12). The movement of bail **59** is limited by its engagement with the stop **85** to limit rotation of the ratchet to one-eighth of a turn. When the spring **53** snaps, stop **85** prevents bail **59** from striking the insulating collar **71** to avoid damage to the collar. Pawl **87** is anchored at **88** to an insulating block **90**. The pawl **87** also prevents reverse movement of the ratchet **47**, when the thermostatic element **35** cools sufficiently to move it counterclockwise from the Fig. 12 through the Fig. 11 and Fig. 10 positions to its initial position illustrated in dotted lines in Fig. 10. During this counterclockwise movement the collar **71** reengages the bail **59** and the spring **53** is rewound. During clockwise heating movement of the thermostatic element **35** it is at first aided by the unwinding action of the spring-mounted bail **59** (Fig. 10) and thereafter may freely move without resistance until it releases the pawl **77**. Therefore, its heating movement toward its tripping position for pawl **77** is relatively unimpeded, which means that this action may take place rapidly and reliably. The thermostatic element **35** is provided at its end beyond the insulating pad with a conductive arm **89** to which is attached a flexible conductor **92** for connection to the above-mentioned terminal **3**. As will be apparent, the circuit to the thermostatic element is broken upon tripping of the switch, and thermostatic motion of the element **35** in a reverse direction occurs as the element cools. Hence the movement of the arm **89** is limited.

The double-throw switch **10** includes the two sets of contacts D and S previously referred to. Each of these, as illustrated, is provided as a bank of contacts. The details of each bank D and S are the same, and the description of one will serve for both, and the same reference numerals are used for each. Each bank of contacts D and S has mounting spring fingers **91**, **93** and **95**, insulated from each other and from the frame by blocks of insulation **97**. Outer fingers **91** and **95** are conductively connected as indicated at **99**. The middle finger **93** of each bank carries a terminal **101** for connection with the aforesaid branches **8** and **9**. A terminal **102** is provided for each of fingers **91** and **95**, each including bolt connection **104** in conductive relation to a finger **91**, and hence (in view of connector **99**) in conductive relation with both fingers **91** and **95**. Terminal **102** on bolt **104** is connected by a wire **111** to frame terminal **96** (Figs. 1 and 7), in this particular instance. Bolts **104** are not in conductive relation with fingers **93** (see insulating sleeve **94**). Behind each finger **95** is a pressure spring follower finger **103** for following engagement with the respective cam **2** or **4** for operating the spring fingers **91**, **93** and **95** to closing and opening positions.

Contacts **107** on the fingers **93** and **95** are preferably

composed of a tungsten-silver alloy or the like, which has a high melting point preventing them from welding together during operation. After one or two operations of such contacts they become somewhat burned and oxidized, thus setting up a relatively high contact resistance.

The cams **2** and **4** are identical. Each is a four-lobed cam. The cam **2** operates the contacts D. The cam **4** operates the contacts S. The cams are mounted on the camshaft **45** out of phase 45°. The arrangement is such that when one cam holds its set of contacts closed, the other set of contacts is open. For example, Fig. 6 illustrates the cam **2** holding contacts D closed, and Fig. 7 illustrates the corresponding position of the cam **4** wherein contacts S are open. Upon rotation of the camshaft through 45° (one-eighth of a turn) from its position shown in Figs. 6 and 7, contacts D open and cam **4** closes contacts S. Upon another one-eighth turn, contacts S open, and contacts D are closed, and so on. Thus, each heating pulse of the thermostatic element **35**, which effects a one-eighth turn of the camshaft **45**, results in opening of the previously closed set of contacts D and S, and closure of the previously open set of contacts.

Contacts **105** on the fingers **91** and **93** are preferably composed of coin silver, which has a high conductivity, although a low melting point. The low melting point is acceptable because these contacts **105** are nonarcing shunt contacts which close only after closure of the circuit by contacts **107** and open before opening of contacts **107**. Thus they never carry an open-circuit voltage drop. Moreover, they provide a low resistance shunt around high resistance contacts **107** when the latter are closed. As above implied, during closing action of the circuit, contacts **107** close first, and then **105**. Thus high-resistance contacts **107** protect contacts **105** against initial inrush of current. Upon opening action, contacts **105** first separate without voltage across them and finally contacts **107** open. Any arc that tends to be formed will be handled by contacts **107**. Since these are of the high-melting variety, they do not melt but maintain the desired high-resistance burned or oxidized condition, useful on the next closing action. In order to protect contacts **105** against voltages as from lightning surges or the like, the end of spring strip **93** is bent toward and over the end of strip **91** to provide a small surge gap **109**.

The contact bank arrangement is particularly adapted for contact protection against high inrush-current, this protection being required where the device is employed in incandescent lamp circuits, as described and claimed in the aforesaid patent application. It will be understood that the load effect of the thermostatic element **35** does not require this contact protection.

As above-mentioned, branches **9** and **8** leading from the double-throw switch **7** are connected to the terminals **101** of the contacts D and S, respectively. When the switch **7** is in position connecting terminal **1** and the branch **8**, and when contacts S are closed (Fig. 4), a current path is established from the terminal **1** through the switch **7**, the branch **8**, the closed contacts S to either of the terminals **94**, thence through a connection **111** between terminal **94** and terminal **96**, thence through the frame **21** (which is conductive) to the fixed end of the thermostatic element **35**, thence through the e'ement **35** and the conductor **92** to the terminal **3**. Similarly, when the switch **7** is in position connecting terminal **1** and the branch **9** and when the contacts D are closed (Fig. 2), a current path is established from terminal **1** through the switch **7**, the branch **9**, the closed contacts D, to the terminal **94**, and thence through the connection **111** to terminal **96**, thence through the frame **21** to the fixed end of the thermostatic element **35**, and thence through the element **35** and conductor **92** to the terminal **3**.

Operation is as follows:

When the switch **7** is thrown from the Fig. 1 to the Fig. 2 position, current flows between the terminals **1** and **3** and heats up the thermostatic element **35**. This current also energizes the relay **6**. The time delay characteristic of the thermostatic element **35** is sufficient to provide a pulse of current of sufficient duration to operate the relay **6** (and any more relays there may be in the relay circuit). As the thermostatic element **35** heats up, it rotates clockwise from its initial position illustrated in dotted lines in Fig. 10 to the Fig. 12 position and, after its time-delay interval, effects rotation of the cams from the position illustrated in Fig. 2 to the position illustrated in Fig. 3 to open the contacts D and close the contacts S. When the contacts D open, inasmuch as the switch **7** is still in the position connecting terminal **1** to the branch **9**, and not in position connecting the terminal **1** to the branch **8**, the flow of current ceases. Assuming that the time-delay characteristic of the thermostatic element **35** is such that the cams are not rotated through their one-eighth step until the elapse of one minute from the instigation of current flow, the transmitted pulse will be of about one minute duration, or at least longer than the operating time of the slowest relay **6** in the circuit.

The duration of a pulse depends upon the current in the circuit and is regulated herein: by shunting the bimetallic thermostatic element **35** with a resistor **109** connected between the connection **111** and terminal **3** as shown in Figs. 1–4; by using a different type of thermostatic element; and, by changing the angular position of the slot **29** and screw **27** relative to the frame **23**. It will be noted that the tension in the spiral thermostatic element is varied by adjustment of screw **27**.

Then when the switch **7** is thrown from its Fig. 3 to its Fig. 4 position, connecting the terminal 1 to the branch line **8**, since contacts S are closed, current again flows through the thermostatic element, for the one minute time interval, and at the termination of this interval, the cams are rotated through a one-eighth turn to open the contacts S and close the contacts D. This restores the control to the status shown in Fig. 1.

It will be seen that the duration of the pulse is entirely dependent upon the time-delay characteristic of the means **11** including the thermostatic element **35**, and is in no way dependent upon the period of time for which the switch **7** remains in one or the other of its positions. That is, simply by throwing the switch **7** to one or the other of its positions, the operation of the apparatus to transmit a pulse of predetermined duration is initiated, and at the termination of the desired interval, the pulse terminates, even though the switch **7** remains in the position to which it was thrown.

In view of the above, it will be seen that the several objects of the inventioin are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A street lighting system comprising a relay circuit, at least one relay connected in the relay circuit and operable in response to successive pulses of current in the relay circuit to make and break a street lamp circuit, and means for intermittently making the relay circuit to transmit a pulse of current in the relay circuit for operating the relay comprising first and second branch circuits in parallel, first and second switches connected in the relay circuit and adapted alternately to connect one of the branch circuits in series in the relay circuit, the first switch having a first position connecting to the first branch and a second position connecting to the second branch, the second switch having a first position connecting to the first branch and a second position connecting to the second branch, whereby the relay circuit is made via the first branch when both switches are in first position or via the second branch when both switches are in second position, an actuator for the second switch operable in steps successively to move the second switch between its first and its second positions, and electrical time-delay means connected in the relay circuit for flow of current therethrough whenever the two switches are in relay circuit making position and controlling the actuator to effect movement of the second switch from whatever position it is in to the other at the termination of the time-delay interval of the time-delay means, whereby a pulse of current of duration corresponding to the time-delay interval is transmitted in the relay circuit when, with the second switch in its first position, the first switch is thrown to its first position and also when, with the second switch in its second position, the first switch is thrown to its second position, and the time-

delay and pulse interval being sufficient for relay actuation.

2. In a relay circuit as set forth in claim 1, the time-delay means including a conductive thermostatic element connected in the relay circuit to be energized and thereby heated upon flow of current in the relay circuit.

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