

Dec. 14, 1954

W. M. ALTHERR

2,697,150

SWITCH APPARATUS

Filed April 16, 1951

3 Sheets-Sheet 1

FIG. 1.

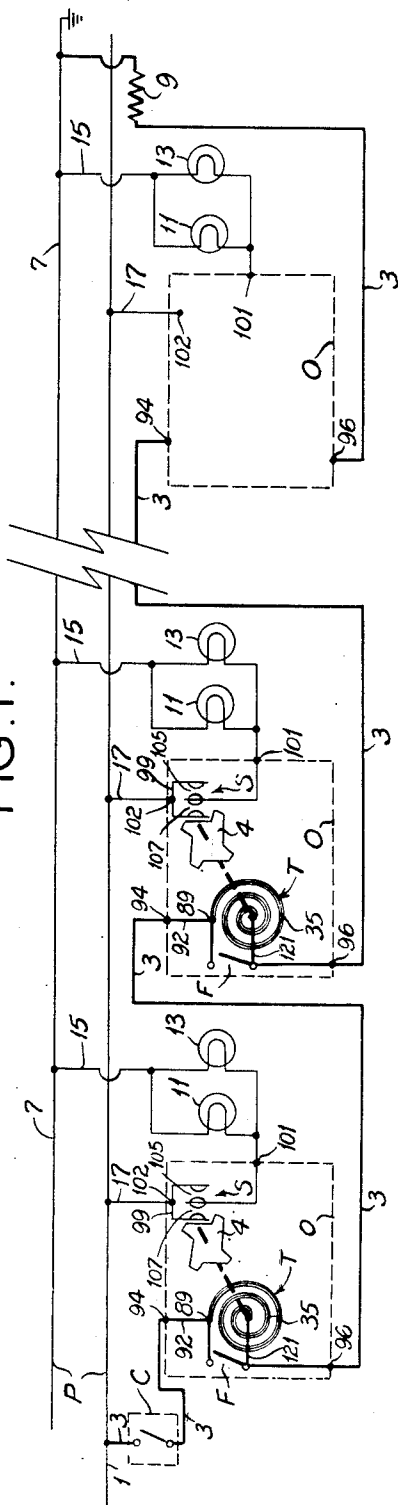
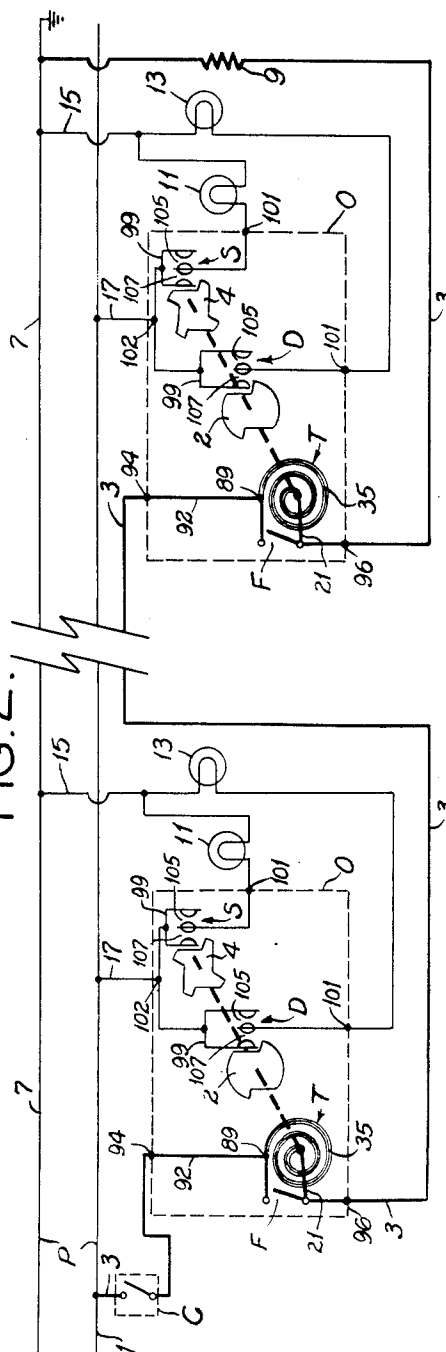


FIG. 2.



Walter M. Altherr,
Inventor.
Koenig and Pope,
Attorneys.

Dec. 14, 1954

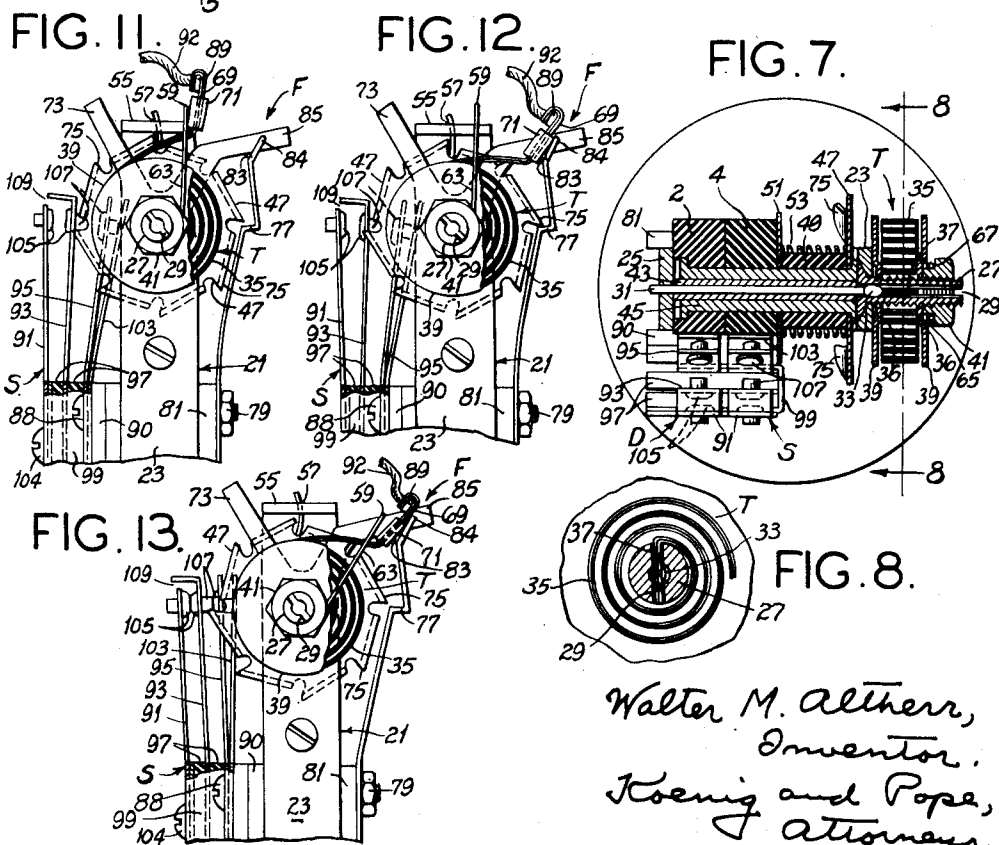
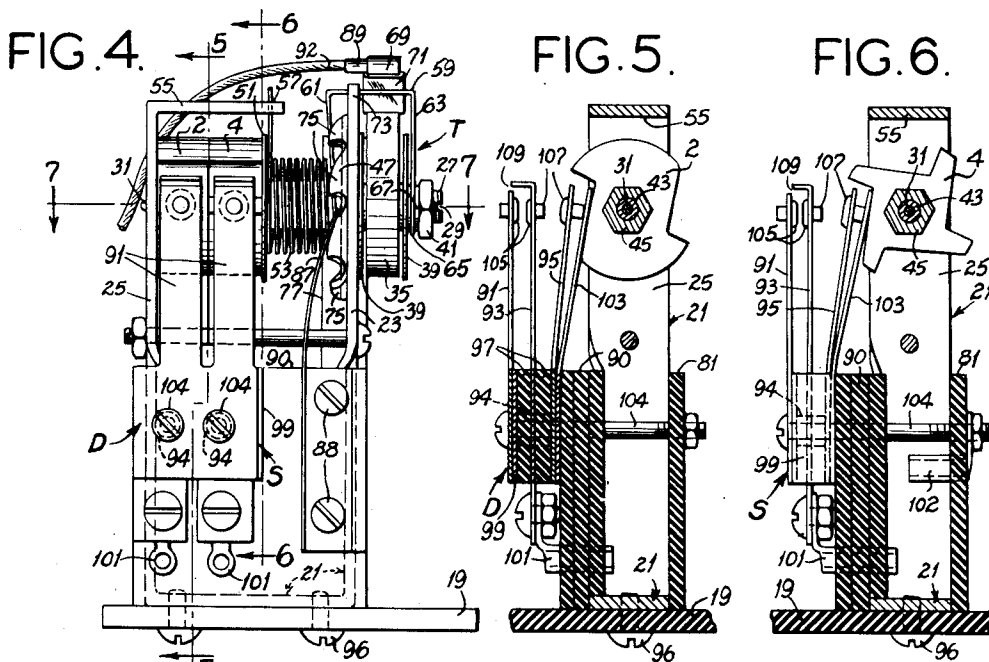
W. M. ALTHERR

2,697,150

SWITCH APPARATUS

Filed April 16, 1951

3 Sheets-Sheet 3



Walter M. Altherr,
Inventor.
Koenig and Pope,
Attorneys.

1

2,697,150

SWITCH APPARATUS

Walter M. Aitherr, St. Louis, Mo., assignor, by mesne assignments, to A. B. Chance Company, Centralia, Mo., a corporation of Missouri

Application April 16, 1951, Serial No. 221,229

8 Claims. (Cl. 200—113)

This invention relates to switch apparatus, and with regard to certain more specific features, to thermostatic switching means for controlling multiple street-lamp lighting circuits or the like. The invention is an improvement upon the construction shown, for example, in United States Patent 2,444,745, dated July 6, 1948.

Among the several objects of the invention may be noted the provision of low-cost, switch apparatus which, without making certain lamp operations simultaneous, reduces the time interval required for a sequence of such operations in response to a control operation; the provision of apparatus of the class described which, as between cold and warm ambient temperature operating conditions, makes said intervals more nearly equal without requiring special ambient temperature compensating means; the provision of apparatus of this class which has no critical operating conditions and which therefore may be more simply, quickly and reliably adjusted, either at the factory or in the field; the provision of apparatus of the class described which is less subject to breakdown under normal operating conditions and under abnormal overload conditions such as from lightning surges or the like, requiring no overload fuses; and the provision of apparatus of this class which requires only a single pilot line for application to any of a wide variety of circuits. Other objects 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 several of various possible embodiments of the invention are illustrated,

Fig. 1 is a circuit diagram illustrating one application of one embodiment of the invention;

Fig. 2 is a circuit diagram illustrating an application of a second embodiment of the invention;

Fig. 3 is a circuit diagram illustrating another application of the invention;

Fig. 4 is a front elevation of one form of switch made according to the invention;

Fig. 5 is a cross section taken on line 5—5 of Fig. 4;

Fig. 6 is a cross section taken on line 6—6 of Fig. 4, being also a cross section on line 6—6 of Fig. 9;

Fig. 7 is a horizontal section taken on line 7—7 of Fig. 4;

Fig. 8 is a cross section taken on line 8—8 of Fig. 7;

Fig. 9 is a view similar to that of Fig. 4 but showing another form of switch made according to the invention;

Fig. 10 is a right-end view of both switch forms shown in Figs. 4 and 9, these forms being identical except for parts that do not show in Fig. 10, the dotted lines illustrating a cover which may be employed;

Figs. 11, 12 and 13 are fragmentary views similar to portions of Fig. 10 but illustrating an operative sequence starting with the Fig. 10 position of parts;

Figs. 14—16 are diagrammatic views of certain cam and contact parts shown on Figs. 5 and 6, and illustrating an operating sequence starting with the positions of parts shown in said Figs. 5 and 6; and,

Fig. 17 is a fragmentary view of certain contacts, showing an alternative construction.

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

In said Patent 2,444,745 is shown improved circuit-

2

control apparatus employing in general a single pilot line which controls thermostatic switches for operating lamps of street-lighting circuits. The advantage of thermostatic switches for the purpose has been that when the pilot line is energized the thermostatic switches inherently have sufficient differences in operating characteristics to prevent all of the control of lamps from being thrown onto the power line substantially at once, as is the case with magnetically operated switches. But such a system requires relatively long intervals between the time that a first lamp turns on or off and the time that a last lamp turns on or off. This may be as much as 15 minutes under not unusual operating conditions. Despite compensation, this interval has been variable between extremes of ambient temperature conditions, and under certain circumstances adjustment of the device has been critical. Also, in certain peculiar (although not all) circuit applications, more than one pilot line has been required. By means of the present invention the stated advantages of this prior system are retained, with additional ones relating to the above matters.

A street-lighting circuit is used in the present description as an example of a type of circuit which may be controlled by the present invention, the advantages of the invention being particularly desirable in such circuits, but this application is not to be taken as limiting.

Referring now more particularly to Figs. 1—3 there is shown at P a 120 v. single-phase portion of an ordinary 120—240 v. three-wire power distribution circuit. Connected to a lead 1 of this circuit is a pilot line 3 in which is an on-off control switch C which may be of any suitable type, operated, for example, either manually or by means of a known type of time clock. Pilot line 3 connects in series certain thermostatic elements 35 of operating switch units hereinafter to be described and the assemblies of which are generally indicated by the dotted lines O in Figs. 1—3. The pilot line 3 is connected to the other side 7 of circuit P through a series resistance 9. At numerals 11 and 13 are typical light bulbs connectible in individual groups across the circuit P by operation of the switch assemblies O. The number of lamps in a group is optional and may be one or more, two being shown. Each group is usually localized in position, as on a single or several poles at some location along a street. Their connections to side 7 of circuit P are shown at 15. Their other connections to the lead 1 of circuit P are shown at 17. These connections are made through suitable cam-operated contact banks S or D within the switch assemblies O. The particular connections in respect to the contact banks S or D depend upon which of several types of switches are to be used at O (described below), and the manner in which the switches are arranged. But in any event, only one pilot line 3 is needed in any of the various applications of operating switch assemblies O, as illustrated, for example, in Figs. 1, 2 and 3. Thus it will be clear that the system is adaptable to a wide variety of applications without multiplying pilot lines such as 3. Certain four-lobed cams for operating the contact bank S are shown at 4. These are operated from thermostats generally indexed T and which will be described in detail below. Certain two-lobed cams for operating the contact bank D are shown at 2 (Figs. 2 and 3). These are also operated from the thermostats T. At F are shown generally certain safety switch components of the thermostats T for preventing their burn-out under certain operating conditions to be described.

Before giving an operating description of Figs. 1—3, details will be described of the structures and functions of switches such as shown generally at O. Referring first to Figs. 4—8 and 10, a form of the switch such as used at O will be described, which incorporates both contact banks S and D and both types of cams 4 and 2, respectively (as applied in Fig. 2). Referring to said Figs. 4—8 and 10, numeral 19 illustrates an insulating base 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 (Fig. 7) 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 a 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. 5 and 6) an eight-toothed ratchet 47, an insulating spacer 49, an insulating washer 51, the four-lobed cam 4 and the two-lobed cam 2. 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. 4. 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 rotatory in the groove 67.

The bail 59 constitutes a pawl drive for the ratchet 47, spring 53 biasing it in forward ratchet-driving direction.

The thermostatic element 35, except at its anchored central portion, 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 counterclockwise (Fig. 10), 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 clockwise (Fig. 10). When the thermostatic element 35 heats, it tends to wind clockwise and the tensioned spring 53 follows it, as illustrated in Fig. 11. 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. 12 and 13), the leg 61 of the bail acting as a driving pawl. 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 to the Fig. 10 initial position. 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. 11) 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 collar 71 with a conductive arm 89 to which is attached a flexible conductor 92 leading to a terminal 94. Upon final clockwise heating movement of the thermostatic element 35, it will engage the conductive stop 85. This will switch or shunt out the thermostatic element from between the terminals 94 and 96. Index F indicates the assembly of parts 85 and 89 considered as a thermostatically operated shunt switch (see also Figs. 1-3), to prevent the coil from being overheated.

As will appear from Fig. 4, 5 and 6, the contact bank S is operated by the four-lobed cam 4, and the contact bank D is operated by the two-lobed cam 2. The details of each bank S and D are the same, and the description of one will serve for both (Figs. 4, 5 and 6) and the same reference numerals will be used for each. Each contact bank S and D 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 for connection with the lines 17 (see also Figs. 1-3). The middle finger 93 of each bank carries a terminal 101 for connection with the lamps 11 and 13. A terminal 102 is provided for each of fingers 91 and 95, each including an insulated 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. Bolts 104 are not in conductive relation with fingers 93 (see insulating sleeve 94). Note that connections 17 attach to terminals 102 (Figs. 1-3). The wires leading from terminals 101 and 102 pass through suitable openings in the base 19. These wires are shown diagrammatically in Figs. 1-3 but not in Figs. 4-10 so as not to confuse the latter. 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 which is useful during initial inrush of current to the lamps 11 and 13 when cold. The lamps, when cold, have about one-twelfth of their hot resistance which increases rapidly with increase in temperature. Thus the high contact resistance is useful to reduce the initial current inrush when the lamps are lighted.

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 contacts 105. Thus high-resistance contacts 107 protect contacts 105 against initial inrush of current into the cold lamps. After the lamps heat up and increase their resistance the subsequent lower current is carried by the shunt contacts 105 with lower resistance. 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.

Figs. 5, 6 and 14-16 diagrammatically illustrate the sequence of action of the cams 4 and 2 in connection with their respective contact banks S and D. Each heating pulse of the thermostatic element 35 results in a one-eighth turn of the camshaft 45. In the case of the four-lobed cam 4, this will cause successive closings and openings of the contact bank S, according to successive 45° movements of the cam 4, assuming an open position at the start. In the case of the two-lobed cam 2, a first 45° movement causes a first closing of contact bank D (compare Figs. 5 and 14). For the next two 45° movements cam 2 holds this bank D closed (compare Figs. 14-16). In the meantime, bank S has alternately closed, opened and reclosed. The following table will make the above clear. The left-hand column in this table indicates the successive 45° angular positions of the cams 2 and 4 covering a two-day operating period. The second column shows the condition of contact bank D and the third column the condition of contact bank S. It will be understood that the 45° rotations of the cams are accomplished by closing of the control switch C at suitable time intervals, as shown by way of example in the right-hand column.

Table

Positions of Cams 2 and 4	Contact Bank D	Contact Bank S	Time
First Day:			
0°	Open	Open	Until 6:00 p. m.
45°	Closed	Closed	6:00 p. m.
90°	do	Open	12:00 m.
135°	do	Closed	5:00 a. m.
180°	Open	Open	7:00 a. m. until 6:00 p. m.
Second Day:			
225°	Closed	Closed	6:00 p. m.
270°	do	Open	12:00 m.
315°	do	Closed	5:00 a. m.
360°	Open	Open	7:00 a. m. until 6:00 p. m.

In some applications of the invention the double-lobed cam 2 and associated contact bank D are not required. In such event the contact bank D may be left out of the final wired circuit, which is one reason for the use of two terminals 101 such as shown in Fig. 4. Or the form of the switch shown in Fig. 9 may be used in which cam 2 and the parts of contact bank D operated thereby are eliminated. In this case most of the remaining parts are identical to those already described, and corresponding reference numerals are therefore applied to corresponding parts which show in Fig. 9. Exceptions are that the U-shaped frame 21 is narrower. It therefore has been renumbered 121. Its legs are renumbered 123 and 125, the extension 55 being renumbered as 155. The shorter pintle is renumbered 131. Otherwise the device of Fig. 9 is the same as that shown in Figs. 4-8. It will be understood that Fig. 10 is a correct right-end view of both Figs. 4 and 9. In Fig. 10 is shown in dotted lines a cover 111, which may be used for outdoor mounting of the switches on poles. A similar cover may be used on the Fig. 4 form of the switch.

In Fig. 1 is shown one application of the invention, in which there is used in each operating switch assembly O a switch of the type shown in Fig. 9, having only one four-lobed cam 4 operating one contact bank S. These switches are wired with their thermostatic elements 35 in series in the pilot line 3. Each contact bank S under control of a cam 4 controls lamps 15, 17 connected in parallel across the circuit P. It will be understood that there is one switch assembly O and one group of lamps 11, 13 on, say, each of a number of poles supporting the wire-forming circuit P and the wire-forming pilot line 3. The exact number of lamps used at 11 and 13 is immaterial and this may be reduced to one or increased to any other number on a given pole within limits. Assume that all of the lamps 11, 13 are to be lighted, say at 6:00 p. m. The control switch C may be operated manually or by a time clock for a suitable interval long enough to assure that all of the thermostatic elements 35 become operative. As soon as the control switch C is closed, a pulse of current flows in series through all of the thermostatic elements 35 in the pilot line 3 and through the resistance 9. Each thermostatic element 35 has a low

resistance, for example, .11 ohm. The conductors of line 3 and resistance 9 are adapted to add a proper resistance to draw a substantial current at 120 volts. Since this additional resistance is relatively high, it makes little difference in the voltage drop across the pilot line whether or not the thermostats are in or shunted out of this circuit. Thus when switch C is closed, an initial pulse of current passes through all of the thermostatic elements 35. The current through each thermostatic element F flows through 94, 92, 89, 35, 121, 96. The arrangement is such that within about 1½ minutes or less, each of the thermostatic elements 35 has moved to trip its pawl 77 with consequent movements of the respective cam 4 through a 45° interval, thus closing the respective contact bank S. This connects all lamps 11 and 13 across the circuit P. Unlike magnetic relays, the thermostatic switches have slight variations in their operating characteristics, and hence do not connect all of the lamps across the line at once. The stated time interval of 1½ minutes or less, is much less than the time interval required by former constructions such as in said Patent 2,444,745, because the thermostatic elements 35 are quickly heated to a high temperature by heavy current flow through them, instead of being indirectly heated by auxiliary heaters. Thus the operating characteristics of the elements 35 are fast and less critically affected by ambient temperature conditions, even without compensation for such conditions. The heating temperatures for operation of the thermostatic elements 35 are, for example, several hundred degrees and entirely out of the range of ambient temperature conditions even on the hottest day. The arrangement is in fact such that if the inrush of current were permitted to continue through these elements 35, they would become red hot and might eventually burn out. This contingency is prevented by reason of the fact that after tripping action of a given switch assembly O has occurred so as to light its lamps 11, 13, continued flow of current causes the respective thermostatic element 35 to move its conductive arm 89 against the stop 85 of frame 21 (compare Figs. 12 and 13). Thus members 89 and 85 constitute the short-circuiting switch F indexed on Fig. 1, which shunts the current around the respective thermostatic element 35. Element 35 then proceeds immediately to cool and move from the Fig. 13 to the Fig. 12 position, whereupon the switch F reopens and the current again flows through the thermostatic element 35. Thus a short-throw repetitive opening and closing action of switch F continues as long as the control switch C is closed. This prevents the thermostatic element 35 from overheating and burning out but in view of its low resistance (.11 ohm) does not substantially change the current in the pilot circuit. This short-throw shunting action does not affect any movement of the respective cam 4 because it is not sufficient to move back the bail 59 to pick up another 45° movement of the ratchet 47. During the pulsing interval, other switches O will be tripping shut and acting likewise. Finally, after the interval of time required for tripping all switches O shut (1½ minutes or so), the control switch C opens (time clock) or is opened (manual operation), whereupon all of the thermostatic elements 35 completely cool. At about 160° F. each thermostatic element 35 has returned to the position shown in Fig. 10, so as to cause its spring 53 to be re-wound and to drop behind a next succeeding tooth 75 of ratchet 47. It requires about 7 minutes for the return action, but the delay here involved is of no disadvantage.

In order to turn off the lights, say at 6:00 a. m., the control switch C is again closed for the requisite time (1½ minutes or so), whereupon the cycle repeats itself, except that in this case each contact bank S reopens.

By way of example, the total resistance in pilot line 3, including the resistance 9, may be about 4 to 9 ohms, which will provide a large current of about 30 to 13 amperes, a proper range of current for reliably and quickly operatively pulsing all of the switch units O within 1½ minutes. If the system is expected to operate in lower ambient temperatures to maintain the 1½ minute operating interval, more pulse current may be used by decreasing the resistance 9. But in any event, the pulsing time for operation is not widely different for large ranges in ambient temperature conditions because of the low resistances of the thermostatic elements 35 with the high currents drawn therein and the resulting high temperature

operations thereof, which operations are fairly constant and independent of said ambient temperature operating conditions. Thus the switch is very reliable in operation, the large current passed through the thermostatic elements 35 assuring reliable and quick movements thereof in the cam-driving directions. It may be remarked that even though adjacent coils of the thermostatic elements 35 might touch, so as to shunt out some of the length of the thermostat, still the reliability and fast action of the thermostat are not substantially affected.

Fig. 2 shows a system which employs in operating units O the switch of Figs. 4-8, which has two cams. This system is intended to be applied and operated as shown in the above table. In some street-lighting circuits it is desirable for heavy evening traffic conditions to turn all the lamps on, say, at a time such as 6:00 p. m., and then at, say, 12:00 m. (when the traffic becomes less), to turn off some of the lamps, leaving the remainder on; then for the morning traffic rush, to turn all the lamps on for an interval starting, say, at 5:00 a. m.; and finally to turn them all off, say, at 7:00 a. m. The above-mentioned table indicates such requirements, and Fig. 2 indicates how the double-cam switch is used in units O in the pilot line 3 to meet these requirements. In this case, switch contact bank S controls lamp 11 and switch contact bank D controls lamp 13, since as shown in Fig. 2 these switches are in the respective parallel lamp connections. Comparison of Fig. 2 with the table, and what has been said above, will make clear the Fig. 2 operation. Obviously each unit O operates once per pulse of current when control switch C closes. In each unit, both cams 2 and 4 operate at once in response to tripping from the respective thermostatic element 35. The sequential operation shown in the table is due to the cam shapes.

It will be understood that in the case of a single-cam switch such as shown in Fig. 9, the two-lobed cam 2 may be substituted for the four-lobed cam 4. Then the wiring shown in Fig. 3 may be employed, alternate groups of lamps 11 and 13 on a line of poles being controlled by alternate units O having four-lobed cams 4 and two-lobed cams 2, respectively. The operation will be similar to that in Fig. 2, except that in Fig. 2 certain pairs of cams 2 and 4 trip simultaneously, whereas in Fig. 3 corresponding pairs of cams 2 and 4 operate only approximately simultaneously. This is because in Fig. 3 each cam 2 or 4 is operated by a separate thermostatic element 35, whereas in Fig. 2 certain pairs of such cams are operated by a single thermostatic element 35. The difference lies in the fact that in Fig. 3 on a given pole there is a switch assembly O incorporating either a cam 4 or a cam 2. Thus all of the lamps on a given pole are either off or on. Hence when some of the lights are off (as distinguished from all of them being on or off) the lamps on certain alternate poles are all on and the lamps on alternate poles are all off. In the case of Fig. 2, all of the lamps on all poles are on or off; or some of the lamps on all poles are on and some off. Thus in the case of Fig. 2, when some of the lamps are off, the brightness of the light from all poles is reduced, whereas in the case of Fig. 3, the brightness of the light from alternate poles is maximum and that from the other alternate poles is zero.

It will be understood that other variations in the switch structures and their applications are possible. For example, in some cities a power circuit such as P is strung along one set of poles on one side of the street and along another set of poles on the other side of the street. Obviously, it would be possible to use units O with four-lobed cams 4 on one side of the street, and units O with two-lobed cams 2 on the other side of the street, with a single pilot line 3 connecting them all in series, operated by one control switch C. Such a system would operate substantially as above described in connection with Fig. 3, except that during partial lighting periods all of the lamps on one side of the street would be out; otherwise, they would all be on or off.

In Fig. 17 is shown an alternative mounting for the contact banks S and D, wherein like numerals designate like parts. In this alternative form there is mounted behind each contact spring 91 a resilient stop bar 201 which limits the clockwise movement of the member 91 upon opening of the switch contacts 105. There is also mounted in front of the central contact spring 93 another resilient stop bar 203 which rapidly damps any vibratory motion that 93 may have imparted to it upon contact opening. These elements further minimize arcing under

large values of current. It is to be understood that the resiliency of the stop bars 201 and 203 is provided so that they permit closure of contacts 105.

It will be understood that although the invention is primarily adapted to control of street-lighting circuits, it may have other applications to circuits wherein the load members are other than lamps. In such a case the contact banks or lamp switches S and D would constitute load switches.

From the above, the stated advantage of the invention will be clear, i. e.,

(1) The structural principles of the thermostatic switches are such that most of the parts are applicable to switches made either with two-lobed cams only, four-lobed cams only, or with both four-lobed and two-lobed cams. Thus production costs are minimized for a wide variety of street-lighting applications.

(2) In the usual street-lighting applications of the invention, only a single pilot wire is necessary, making control possible from a single control switch. This reduces installation costs.

(3) The operating time for connecting or disconnecting all or some of the lamps is considerably reduced (without making it zero) and made more independent of ambient temperature conditions, without the necessity for temperature-compensating elements in the switches.

(4) The switches are easy to adjust and reliable in operation under overload conditions without the necessity for the use of protective fuses.

Cross reference is here made to my copending divisional application, Serial Number 322,279, filed November 24, 1952, for Circuit Control System.

In view of the above, it will be seen that the several objects of the invention 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. Thermostatic switch apparatus comprising a support, a switch carried by the support, switch-operating mechanism carried by the support, drive means for said mechanism mounted on the support adapted for forward movement from a retracted position to drive said mechanism, and being spring-biased in forward mechanism-driving direction, a stop for said mechanism mounted on the support for movement between a mechanism-engaging position and a disengaging position freeing the mechanism, a thermostatic element mounted on the support and having a free portion movable in one direction upon heating of the element and in return direction upon cooling of the element, said free portion normally engaging the drive means and holding it in its retracted position, and being movable away from the drive means and toward engagement with the stop upon heating of the element for moving the stop to its disengaging position, the stop holding said mechanism against movement by the drive means until said free portion engages the stop, whereby the drive means, under its spring bias, drives said mechanism and overtakes said free portion, said free portion moving in return direction upon cooling of the element to return the drive means to retracted position.

2. Thermostatic switch apparatus made according to claim 1, wherein said thermostatic element is connected into an electric circuit adapted to heat the element, and wherein the apparatus includes a shunt switch adapted to be closed by the thermostatic element after its free portion has moved said stop to its disengaging position to shunt the flow of current around the thermostatic element.

3. Thermostatic switch apparatus comprising a support, a switch carried by the support, a ratchet movable on the support, means driven by the ratchet for opening and closing the switch, a pawl drive for the ratchet movably mounted on the support and engageable with the ratchet, said drive being movable forward from a retracted position to drive the ratchet, and being spring-biased to move in forward ratchet-driving direction, a releasable stop for the ratchet mounted on the support for movement between a ratchet-engaging position and a retracted position freeing the ratchet, a thermostatic element mounted on the support and having a free portion movable in one direction upon heating of the element and in return direc-

tion upon cooling of the element, said free portion normally engaging the drive and holding it in its retracted position, and being movable away from the drive and toward engagement with the stop upon heating of the element for moving the stop to its retracted position, the stop holding the ratchet against movement by the drive until said free portion engages the stop and moves it to its retracted position, whereupon the drive, under said spring bias, drives the ratchet and overtakes said free portion, said free portion moving in return direction upon cooling of the element to return the drive to retracted position.

4. Thermostatic switch apparatus made according to claim 3, wherein said thermostatic element is connected into an electroc circuit for heating the element, and wherein the apparatus has a shunt switch adapted to be closed by the thermostatic element after its free portion has moved said stop to its retracted position to shunt the flow of current around the thermostatic element.

5. Thermostatic switch apparatus comprising a support, a switch carried by the support, a cam rotary on the support and adapted upon rotation successively to open and close the switch, a ratchet rotary on the support connected with the cam for rotating the cam, a pawl drive for the ratchet movably mounted on the support and engageable with the ratchet, said drive being movable forward from a retracted position to drive the ratchet, and being spring-biased to move in forward ratchet-driving direction, a releasable stop for the ratchet mounted on the support for movement between a ratchet-engaging position and a retracted position freeing the ratchet, a thermostatic element mounted on the support and having a free portion movable in one direction upon heating of the element and in return direction upon cooling of the element, said free portion normally engaging the drive and holding it in its retracted position, and being movable away from the drive and toward engagement with the stop upon heating of the element for moving the stop to its retracted position, the stop holding the ratchet against movement by the drive until said free portion engages the stop and moves it to its retracted position, whereupon the drive, under said spring bias, drives the ratchet and overtakes said free portion, said free portion moving in return direction upon cooling of the element to return the drive to retracted position.

6. Thermostatic switch apparatus made according to claim 5, wherein the free portion of the thermostatic element is electrically attached to one side of a circuit, the other end thereof being in electrical contact with the support, the support being electrically connected to the other side of said circuit, and contacts on said support and said free portion adapted to be engaged to shunt the thermostatic element upon a predetermined movement thereof after movement of said stop to retracted position.

7. Thermostatic switch apparatus made according to

claim 5, wherein said thermostatic element is constituted by a spirally coiled bimetallic strip.

8. Thermostatic switch apparatus comprising a support, a switch carried by the support, a cam rotary on the support and adapted upon rotation successively to open and close the switch, a ratchet rotary on the support connected with the cam for rotating the cam, a pawl drive rotary on the support and engageable with the ratchet, said drive being swingable forward from a retracted position to drive the ratchet, and being spring-biased to swing in forward ratchet-driving direction, a releasable stop for the ratchet mounted on the support for movement between a ratchet-engaging position wherein it stops forward rotation of the ratchet by the pawl drive and a retracted position freeing the ratchet for forward rotation, a holding pawl mounted on the support for holding the ratchet against rotation in reverse direction, a bimetallic conductive spiral thermostatic element anchored at its inner end to the support and having a rotary outer portion movable in one direction upon heating of the element and in return direction upon cooling of the element, said element being adapted for connection in a circuit for flow of current therethrough to heat it, said outer portion normally engaging the pawl drive and holding it in its retracted position, and being movable away from the drive and toward engagement with the stop upon heating of the element for moving the stop to its retracted position, the stop holding the ratchet against movement by the drive and thereby holding the drive in its retracted position until said outer portion engages the stop and moves it to its retracted position, whereupon the drive, under said spring bias, drives the ratchet and overtakes said outer portion, said outer portion moving in return direction upon cooling of the element and being adapted to engage and return the drive to its retracted position, a shunt contact on said outer portion of the element, and a shunt contact on the support engageable by said shunt contact on said outer portion upon continued movement of said outer portion after the stop has been moved to its retracted position in response to continued heating of said element, the shunt contact on the support being electrically connected to the inner end of the element for shunting the element upon engagement of the contacts.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,535,360	Vickery	Apr. 28, 1925
2,125,765	Butler	Aug. 2, 1938
2,444,745	Mosley	July 6, 1948
2,505,689	Richmeyer	Apr. 25, 1950
2,549,532	Seaman	Apr. 17, 1951