June 11, 1940. S. G. CRANE 2,203,719

ELECTROTHERMAL MOTOR

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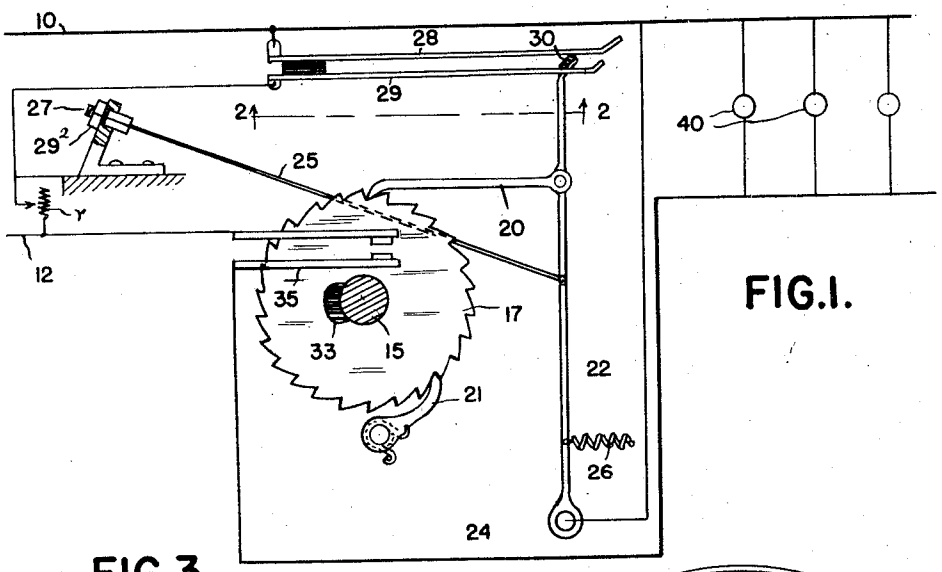



FIG.1.

FIG.3.

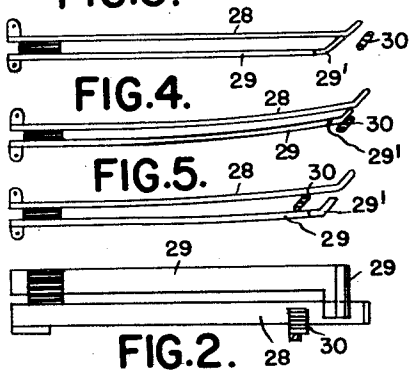



FIG.4.

FIG.5.

FIG.2.

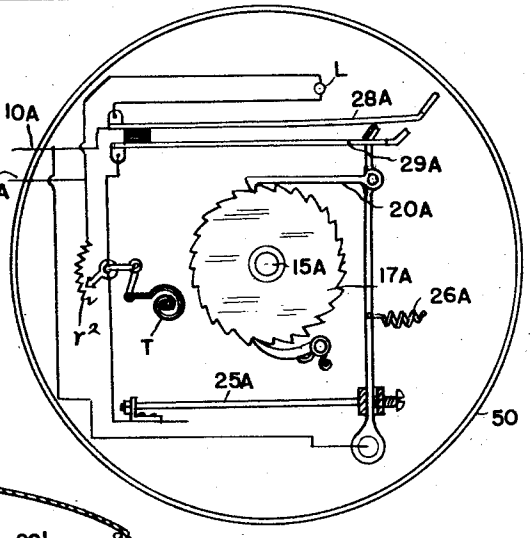
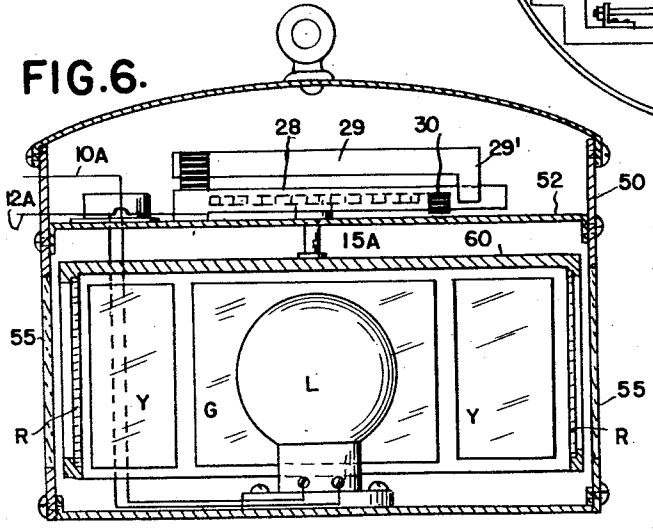



FIG.7.

FIG.6.




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FIG.11.

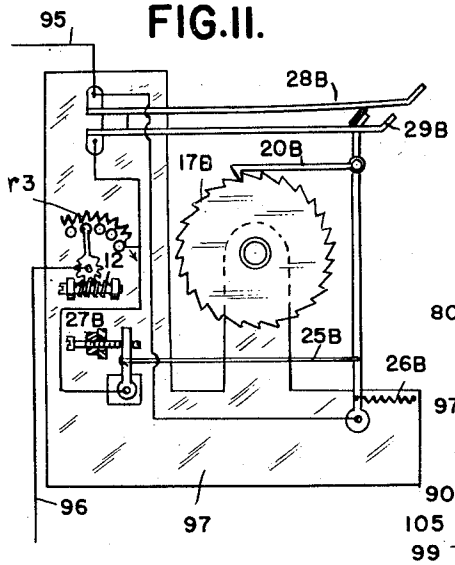



FIG.9.

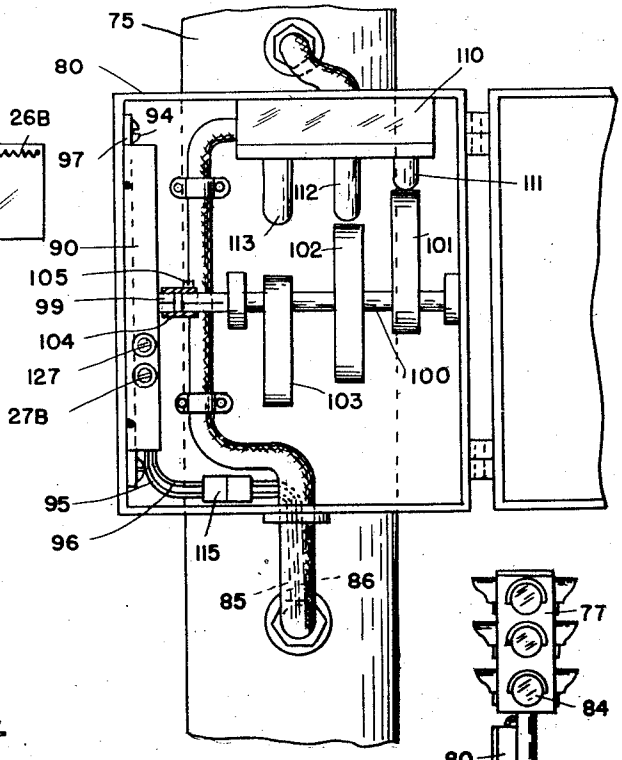
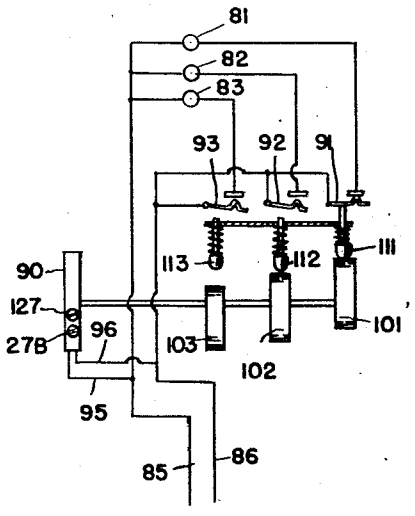



FIG.10.



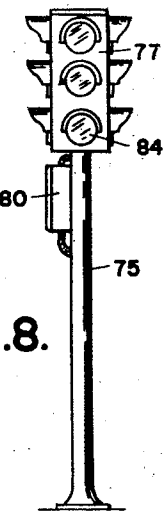




FIG.8.

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# UNITED STATES PATENT OFFICE

2,203,719

## ELECTROTHERMAL MOTOR

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Application March 14, 1938, Serial No. 195,789

5 Claims. (Cl. 172—126)

This invention relates to electrothermal actuators, for controlling and driving desired apparatus. Although mechanisms incorporating the invention are particularly suitable for the operation of controlling devices for electric circuits, many other uses will be manifest to those skilled in the art.

An important object of the invention is to provide timed intermittent automatically operable circuit interrupting means of novel and extremely simple character, which will continue to function as long as current is supplied, which may be shunted across the power feed lines of a circuit to be controlled, drawing very little current and requiring no supervision or attention.

A further object is to provide such mechanism capable of imparting timed intermittent actuation to a driven object, and which is particularly adapted for switch operation.

Still another object is to provide such intermittent motivating means for switches and the like having electrothermally operated contacts which although they control the entire operation carry but very light loads, eliminating harmful arcing, while in addition, if switching means is operated, quick breaking of the contacts is achieved, also obviating harmful arcing in the controlled apparatus and enabling the use of simpler switch constructions than would otherwise be possible.

Other objects and advantages will be apparent from the following description, wherein reference is made to the accompanying drawings illustrating preferred embodiments of my invention and wherein similar reference numerals designate similar parts throughout the several views.

In the drawings:

Figure 1 is a diagrammatic plan view showing a structural embodiment of the invention, and also schematically showing the electrical connections of the elements thereof;

Figure 2 is a sectional elevation showing the control switch means, taken substantially on the line 2—2 of Figure 1 and looking in the direction of the arrows;

Figures 3, 4 and 5 are plan views of the control switch means, progressively showing the contact arms thereof in positions they assume during operation of the apparatus;

Figure 6 is a substantially diametric vertical sectional view of an automatic signal light construction, suitable for traffic control and the like, incorporating control switching means constructed in accordance with the invention, but somewhat modified in its arrangement;

Figure 7 is a plan view thereof with the lid removed, also of somewhat diagrammatic character and schematically showing the electrical connections of the several components.

Figure 8 is a side elevational view of a traffic light signal assembly, controlled by mechanism constructed in accordance with this invention.

Figure 9 is a front elevational view of the control switch box, with the door open and partly broken away.

Figure 10 is a schematic diagram, and

Figure 11 is an elevation of the mechanism of the electrothermal timer motor.

In Figure 1 a source of current is indicated by the feed wires 10, 12. Motor shaft 15 is driven intermittently, through the agency of a ratchet wheel 17 mounted thereon, operable by a pawl 20 pivoted to a lever 22 swingable about a fixed axis indicated at 24. The lever is swingable in one direction by the contraction of a hot wire 25, and movable in the opposite direction by a spring 26 when the wire expands, the pawl being thus alternately reciprocated to turn the ratchet wheel and shaft.

The hot wire is incorporated in a shunt control circuit which includes a load *r* and a pair of contact arms 28, 29, comprising a control switch which is biased to close. When contacts 28, 29 are closed, they short circuit the hot wire, while when they are open, the current of the shunt circuit flows through the hot wire, consequently expanding it. The contact arms 28, 29 are also operated by the lever 22, which is insulated therefrom. The contact arms may be formed of spring material and arranged tangentially to the path of the end of the lever, which carries an inclined insulated plate 30 acting as a cam to actuate them. The shape of such arms is clearly shown in Figures 1 and 2.

When the lever is at the left of its path of travel, as viewed in the drawings, it bears against contact arm 28, urging it away from arm 29 and breaking the short circuit. While moving to the right, the cam plate maintains the contacts separated until it has passed out from between and is entirely clear of them, when the contacts close. While at the right of its travel, and during its movement to the left, the cam plate maintains the contacts in engagement. This action is achieved by offsetting the spring contact arms in two planes, as shown in Figure 2, and by their cooperative shape. The extremity of arm 28 is bent away from the fulcrum of the lever in a direction substantially parallel to the cam plate, while the end of arm 29 is similarly inclined. The main portion of arm 29 is above

the path of the cam plate, but its end extends angularly downwardly into the path of the cam plate and to overlie a portion of the arm 28, as indicated at 29'. The arrangement of these parts will be seen to be such that as the cam plates moves to the right it slides between portion 29' and arm 28, keeping them separated, while when the plate moves to the left it rides over the nearer side of the laterally projecting portion 29', forcing it against the contact 28 while riding thereover. After it has cleared such laterally projecting portion in its movement to the left, the plate allows portion 29' to move away from arm 28, the latter being simultaneously flexed away from arm 29.

The hot wire 45 is thus alternately expanded by the heating effect of the current and contracted when short circuited intermittently turning the ratchet wheel and so the shaft 15, which is indicated as carrying a cam 33 for actuating switch contact 35 to open and close the circuit through the conductor 12. In this manner the load is energized and deenergized. Although the cam and switching means are shown as of simple construction for the sake of clarity, and the load is shown as comprising electric light bulbs 40, it will be obvious to those skilled in the art that almost limitless variation of the switching means and controlled apparatus may be indulged in. Bulbs 40 may form part of an advertising sign, or of a signal or traffic light system or the like.

For purposes of adjustment the hot wire 25 is connected to a threaded stem 27 provided with an adjusting nut 29 whereby the initial positioning of the wire, and accordingly its reaction time, may be adjusted. It will be appreciated that by moving the point of attachment of the wire toward or from the fulcrum 24, the force developed and extent of movement imparted to the lever may be changed to suit the wishes of the designer. An additional pawl 21 may be provided to prevent reverse movement of the ratchet wheel, in the well known manner.

In the somewhat modified arrangement shown in Figures 6 and 7, in which parts analogous to those already described have been given like reference characters distinguished by the addition of the letter "A" to each, the ratchet wheel 17A is driven forwardly by the spring 26A and returned by the hot wire 25A, the hot wire being alternately short circuited by spring contacts 28A, 29A which are similarly operable. The load $r^2$ which determines the characteristics of the shunt circuit may comprise a variable resistance, controllable by a thermostat T linked or otherwise appropriately coupled thereto to increase the resistance of the shunt circuit in response to a rise of atmospheric temperature, and vice versa. The variation of such resistance may be sufficient to compensate for temperature changes, and to maintain substantially constant the rate of operation of the lever and so the speed of driven shaft 15A.

The apparatus, diagrammatically illustrated in Figure 7, is shown in Figure 6 as installed in a casing 50, upon a horizontal partition 52 thereof, the shaft 15A being located centrally and projecting downwardly through the partition in which it is journaled. The casing, which is of circular cross section, is provided with window openings 55, and aligned with these and rotatable in the compartment below the partition 52, is a drum 60, suspended and drivable by the shaft 15A. The drum is provided with translucent wall panels designated R, Y and G registrable with the window openings 55. These translucent panels may be colored red, yellow and green, as indicated by the reference letters given them, so that the light source L within the assembly may cause the windows 55 to be illuminated in accordance with the color of the panels aligned therewith. The light bulb L may be energized from the same power lines 10A, 12A, that supply the motor mechanism, and it will be understood that the windows 55 may be located to be visible in desired directions from a highway intersection or other intersection at which traffic is to be controlled. The red, yellow and green panels may be varied in their circumferential length to cause the lights of the different colors to show for desired intervals as the drum 60 rotates.

The indicated method of operating a traffic signal is an especially safe and desirable one because while the yellow panels are visible, and during the greater portion of their travel across the windows 55, persons watching the signal can also see which colored light will next appear, thus being given ample warning of the approach of the red signal.

Another traffic signal control arrangement, somewhat more conventional in its appearance and operation, is shown in Figures 8, 9, 10 and 11. The traffic signal is shown as comprising a post 75 carrying at its top a casing 77 within which are housed lights as 81, 82, 83. These may be covered by suitably colored lenses as 84 to give them the red, green and yellow or other desired colors.

Illumination of the lights $o$ is controlled by timed motor-switch mechanism housed in a box 80 attached to the post 75. The power lines by which the lights and the timer mechanism are supplied with current are designated 85, 86. One of these (85) leads directly to the light bulbs 81, 82, 83, while in series with each of the return lines from the bulbs is a switch 91, 92, 93, operable by cams 101, 102, 103, respectively, mounted upon a camshaft 100 journaled in the casing and operable by a thermoelectric motor generally designated 90, the construction and operation of which may correspond generally to the electrothermal motors previously described.

The switches are thus individually operable to energize the several lights at desired spaced intervals, and for periods determined by the cam contours and the rate at which the shaft is driven by the motor 90. The cams actuate the switches through follower plungers 111, 112, 113, all housed with the switches, in a single casing 110, secured to and within the box 80. The motor 90 is removably fastened to one wall of the box as by screws 94, and its power shaft 99, when the motor is so installed, aligns with the end of camshaft 100. The abutting ends of these shafts are squared, and a correspondingly shaped drive bushing 104 serves as a coupling therebetween. The bushing is slidable over the shaft 100 when the set screw 105 is loosened, to permit freeing the motor shaft 99 and removal of the motor assembly, whose feed wires 95, 96 are separably connected to the power lines 85, 86, as by a plug and jack connector 115.

All of the mechanism of the timer motor is carried by a frame plate 97, which forms the bottom wall of the motor enclosure. The portions of the mechanism analogous to parts already described have been given like reference characters distinguished by the addition of the letter "B." The tension and initial position of the hot wire 25B are adjustable by means of a screw 27B, while the resistance-load $r^3$ is also variable by a

worm screw 121. Both such screws are accessible when the door of the box 80 is opened, as shown in Figure 9.

What I claim is:

1. An electrothermal actuating device comprising in combination with a source of current, an element heatable and expansible by the current from said source, translating mechanism including ratchet and pawl members, one of said members being connected to and actuable by said heatable element and the other being driven by the member so connected to the heatable element, switching means for intermittently applying the current to said element to cause the same to expand and contract alternately, operative connection between said translating mechanism and switching means for operating the latter in timed relation to the former, said switching means when closed short-circuiting said heatable element, and a predetermined load in series with said heatable element and switching means.

2. An electrothermal actuating device comprising in combination with a source of current, an element heatable and expansible by the current from said source, translating mechanism including ratchet and pawl members, one of said members being connected to and actuable by said heatable element and the other being driven by the member so connected to the heatable element, switching means for intermittently applying the current to said element to cause the same to expand and contract alternately, operative connection between said translating mechanism and switching means for operating the latter in timed relation to the former, said switching means when closed short-circuiting said heatable element, a predetermined load in series with said heatable element and switching means, and means for varying said load to accord with changing temperature conditions.

3. An electrothermal actuating device comprising in combination with a source of current, an element heatable and expansible by the current from said source, translating mechanism including ratchet and pawl members, one of said members being connected to and actuable by said heatable element and the other being driven by the member so connected to the heatable element, switching means for intermittently applying the current to said element to cause the same to expand and contract alternately, operative connection between said translating mechanism and switching means for operating the latter in timed relation to the former, said switching means when closed short-circuiting said heatable element, a variable load in series with said heatable element and switching means, and thermostatic means responsive to changing atmospheric temperature and connected to said variable load to change the same in accordance with such changes of temperature.

4. An electrothermal actuating device comprising in combination with a source of current, an element heatable and expansible by the current from said source, translating mechanism including ratchet and pawl members, one of said members being connected to and actuable by said heatable element and the other being driven by the member so connected to the heatable element, switching means for intermittently applying the current to said element to cause the same to expand and contract alternately, operative connection between said translating mechanism and switching means for operating the latter in timed relation to the former, said switching means when closed short-circuiting said heatable element, said mechanism comprising pawl and ratchet members, said switching means being arranged when closed to short circuit the heatable element, and comprising contactors electrically separable in response to movement of the member to which the heatable element is connected in one direction, and electrically closable in response to movement of said member in the opposite direction.

5. An electrothermal actuating device comprising in combination with a source of current, an element heatable and expansible by the current from said source, translating mechanism including ratchet and pawl members, one of said members being connected to and actuable by said heatable element and the other being driven by the member so connected to the heatable element, switching means for intermittently applying the current to said element to cause the same to expand and contract alternately, operative connection between said translating mechanism and switching means for operating the latter in timed relation to the former, said switching means when closed short-circuiting said heatable element, said mechanism comprising pawl and ratchet members, said switching means comprising a pair of independently movable contact arms biased to close, an actuating portion movable into contact with one of said arms to move it away from the other during movement of said portion in one direction, and engageable with the other arm to move it toward the first mentioned arm during movement of the actuating portion in the opposite direction, one of said arms having a portion normally lying in the operative path of movement of said actuating portion, the other arm lying outside said path but having a portion projecting thereinto and lying at such angle with respect to said path of movement of the actuating portion as to cause the latter to force itself between the first mentioned arm and the other arm when said actuating portion is moving in one direction, and to ride over the outside of said projecting portion and tend to maintain said arms in engagement during movement of said actuating portion in the opposite direction.

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