July 31, 1962 F. J. BILTZ 3,047,825

COMBINATION VARIABLE RESISTOR AND SWITCH

Filed Oct. 23, 1961

2 Sheets-Sheet 1

FIG. 1

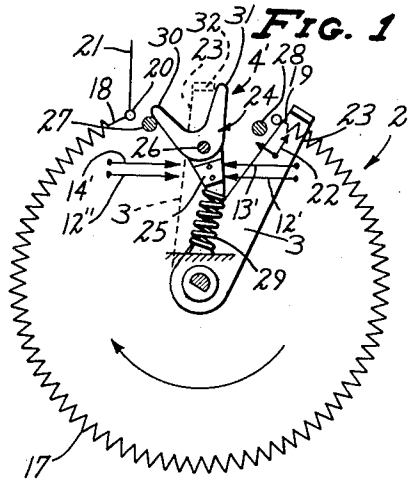


FIG. 2

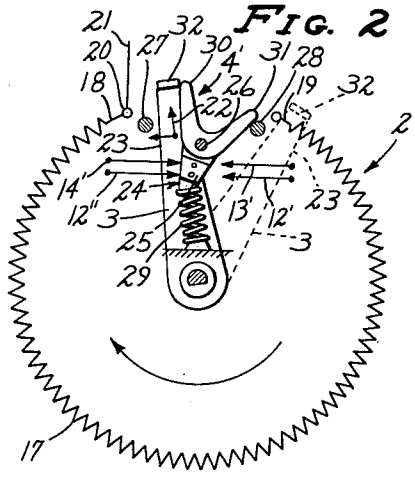


FIG. 3

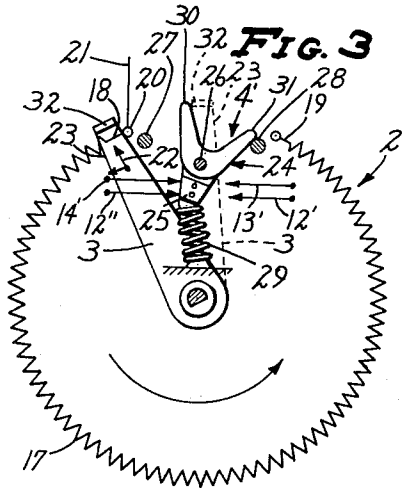


FIG. 4

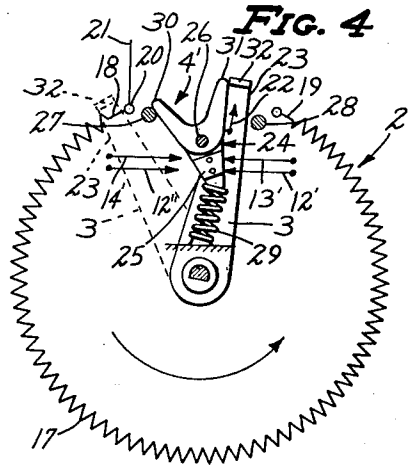
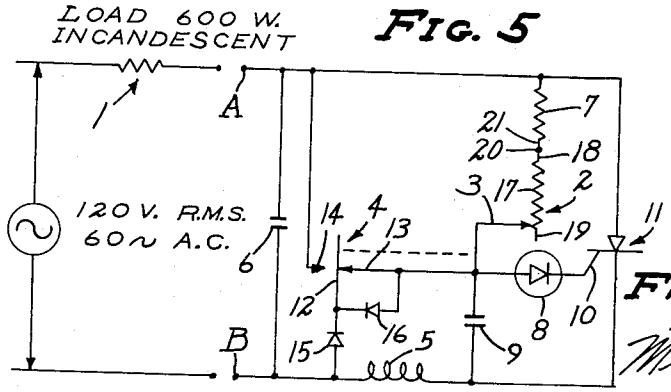


FIG. 5



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FIG. 6

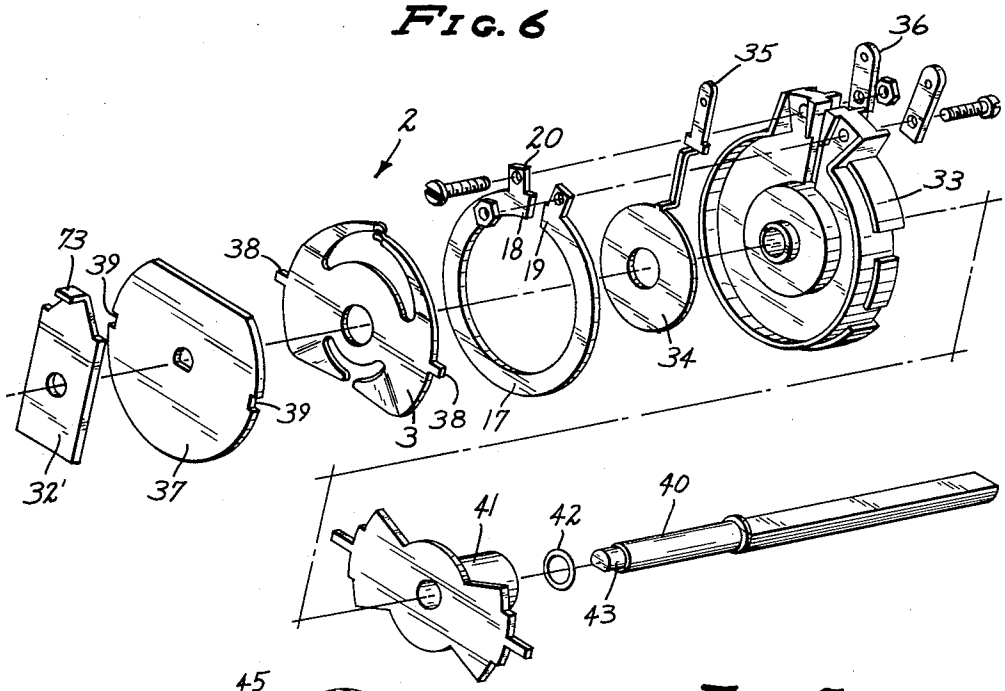
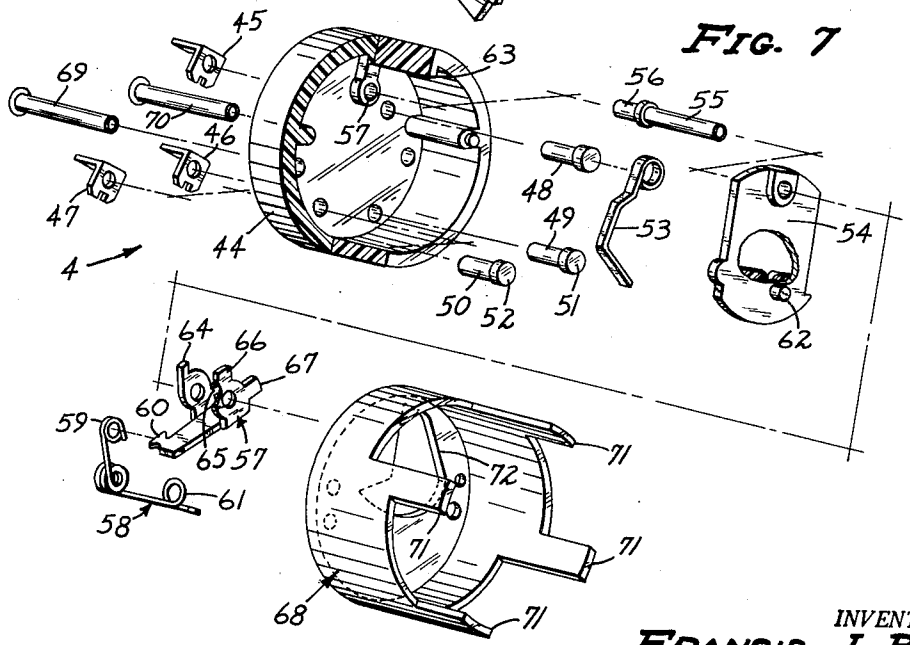


FIG. 7



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3,047,825
COMBINATION VARIABLE RESISTOR AND SWITCH

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2 Claims. (Cl. 338—172)

My invention relates to a novel and improved variable resistor and switch combination.

An object of my invention is to provide a structure which would effect in an electrical circuit a pair of variable resistances of generally like characteristics, one being effective in the circuit at a time, and a switch in the circuit which could be actuated at a point when one of the variable resistances was cut out of the circuit and the other variable resistance became effective in the circuit; preferably, to provide a structure which would have a single control member which could be moved to vary the resistance of one of the resistors from maximum to minimum resistance, actuate a switch, and then vary the resistance of a second resistor from maximum to minimum resistance, and which then could reverse to vary the resistance of the second resistor from minimum to maximum resistance, actuate the switch and then vary the resistance of the first resistor from minimum to maximum.

A further object of my invention is to provide a control potentiometer or variable resistor and switch combination which would be effective in the circuit disclosed in FIG. 5 hereof.

A still further object of my invention is to provide such control structure which would be compact, simple in operation, easily manufactured and yet relatively inexpensive to manufacture.

The above and still further important objects and advantages of my invention will be apparent from the following specification, appended claims and attached drawings.

Referring to the drawings, which illustrate my invention, and in which like reference characters indicate like parts throughout the several views:

FIGS. 1–4 are schematic diagrams showing my novel variable resistor and switch combination in various positions;

FIG. 5 is a circuit diagram showing an application of my invention;

FIG. 6 is an exploded view in perspective showing for the most part the variable resistor components of my invention; and

FIG. 7 is an exploded view in perspective showing for the most part the switch components of my invention to be connected to and used in conjunction with the components shown in FIG. 6.

Referring more particularly to the drawings, FIG. 5 discloses a schematic diagram of a circuit for providing illumination control of an incandescent lamp, indicated generally by the numeral **1**. The circuit of FIG. 5 which may be referred to generally as a dimmer control circuit provides for varying the illumination of lamp **1** between minimum and maximum illumination through control of the variable potentiometer or rheostat, indicated generally by the numeral **2**. The wiper arm **3** of potentiometer **2** is associated with a switch, indicated generally by the numeral **4**. Potentiometer **2** and switch **4** comprise the subject matter of my invention described and claimed in this application. It should be understood that the dimmer control circuit of FIG. 5, apart from said potentiometer **2** and switch **4**, is shown and described herein for the purpose of showing the subject of this invention in operable relation in a circuit; and it aids in pointing up the advantages and objects of the instant invention. A particular

problem solved by my invention was to provide a combination potentiometer and switch which could serve the multiple functions necessary in the dimmer control circuit of FIG. 5 and which yet would be simple, easily operated, and readily and cheaply manufactured, as mentioned hereinbefore.

Terminals A and B of the dimmer control circuit are adapted to be connected to a source of alternating current, which may be the usual power supply of 120 volt 60 cycle alternating current, and to the incandescent lamp load, indicated by the numeral **1** which may be one or a plurality of lamps, as such connections are shown in FIG. 5. The dimmer control circuit of FIG. 5 comprises an inductor **5**, which is a small radio frequency interference. Inductor **5** can be considered a short circuit and capacitor **6** as non-existent so far as the functional operation of the dimmer control circuit is concerned at the power line frequency indicated.

Resistor **7** is a low wattage protective resistor for the purpose of limiting the current through the resistance of potentiometer **2** when it is at a minimum. The diode element indicated by the numeral **8** is a small PNPN diffused silicon switching diode of the avalanche type characterized by providing an open circuit up to a controlled voltage point after which it provides a short circuit until the current diminishes to its minimum holding current, at which point it reverts to an open circuit. Diode **8** is similar to a neon gas device except for its lower voltage breakdown, lower voltage drop in the conducting mode, and the fact that it switches in the order of micro-seconds. Capacitor **9** is connected through diode **8** to the gate **10** of a silicon controlled rectifier **11**. The operation of silicon controlled rectifier **11** is known to those skilled in the art; but briefly, the rectifier **11** is normally non-conductive but shall become conductive, and effectively a short circuit, at a point during the positive half-wave cycle of the alternating current source when a control voltage is applied at its gate **10**. This control voltage to gate **10** is supplied by the discharge of capacitor **9** upon the breakdown of diode **8**. The combination of resistor **7**, resistance of potentiometer **2**, and capacitor **9** controls the time at which the positive voltage amplitude across capacitor **9** equals the breakdown voltage of diode **8**; and this in turn is variable and controlled by the position of wiper arm **3** of potentiometer **2**.

Switch **4** comprises a movable contact **12** and fixed contacts **13** and **14**. When movable contact **12** is in contact with fixed contact **14**, the power diode-type half-wave rectifier **15** allows essentially full conduction of the negative half cycle of applied line voltage to the incandescent lamp **1**. At the position of switch **4** shown in FIG. 5, half-wave rectifier **15** is out of circuit to provide negative conduction to the load or incandescent lamp **1** and the only possible current path from terminal A to terminal B is through the silicon controlled rectifier **11**; and in this position of switch **4**, half-wave rectifier **15** prevents capacitor **9** from being charged negatively.

Diode **16** is a small, low current, general purpose diode which is short circuited at the position at switch **4** shown in FIG. 5; however, at the other position of switch **4**, when movable contact **12** is in contact with switch contact **14**, diode **16** is connected in such manner as to discharge the residual positive charge of capacitor **9** between positive half-wave pulses for the purpose of preventing flickering in lamp **1**. This important feature forms no part of the invention of the instant application and it need not be described in detail.

The foregoing brief description of the components of the circuit of FIG. 5 gives a brief background for the subject of the instant invention, which is potentiometer **2** and its associated switch **4**. The operation of the circuit of FIG. 5 will be better understood after a fuller

explanation of the structure and function of potentiometer 2 and its associated switch 4.

Turning now to FIGS. 1–4 of the drawings, these drawings show schematically the variable resistor and switch combination of the instant invention in various positions.

The numeral 17 indicates the resistive element of potentiometer 2; and resistive element 17 is generally circularly disposed with its opposite ends 18 and 19 spaced apart with resistive element 17 extending through substantially 360°, as is common in commercial potentiometer construction. End 18 is connected to a conductor terminal 20, which in turn is adapted to be connected by lead 21 to resistor 7 as shown in FIG. 5. Wiper arm 3 is mounted for rotation about the axis of resistive element 17; and the conductive elements of wiper arm 3 are indicated schematically by the right angle arrows indicated generally by the numeral 22 at end portion 23 of wiper arm 3.

The switch associated with potentiometer 2 can take a variety of forms. In its simplest form, the switch may comprise a simple two-terminal on-off switch (single pole single throw) which may consist either of two fixed terminals with a contact element movable into or out of connecting engagement with the two fixed contacts or a two-terminal on-off switch with a fixed contact associated with one terminal and a movable contact element associated with the second terminal. The switch might also preferably comprise a single pole double throw switch either of a type as shown in FIG. 5 or of a type as shown schematically in FIGS. 1–4.

The switch of FIGS. 1–4 will be indicated generally by the numeral 4'; and it comprises a pair of fixed contacts 13' and 12' and a pair of fixed contacts 14' and 12''. The terminals of contacts 12' and 12'' can be conductively connected together to provide the equivalent switch arrangement of FIG. 5. The movable contact element of switch 4' is indicated by the numeral 24; and it comprises a contact portion 25 which at one position conductively bridges fixed contacts 13' and 12' and at the other position conductively bridges contacts 14' and 12''. Element 24 is mounted on pin 26 for limited swinging movements between stops 27 and 28. Element 24 is toggle-acting and is biased by spring 29 away from dead center relationship and alternately into engagement with either one of stops 27 and 28. When element 24 is in engagement with stop 27, contact portion 25 engages switch element 13' and 12'; and when element 24 engages stop 28, contact portion 25 engages switch elements 14' and 12''. Switch element 24 has a pair of ear-like projecting portions 30 and 31. Wiper arm 3 has a switch actuating element or portion associated with it, which in FIGS. 1–4 consists of a laterally projecting end portion 32. Switch element 24 is positioned in relation to the movement of wiper arm 3 so that at one position thereof one of the projecting portions 30 and 31 is in the path of travel of switch actuating portion 32 and the other is out of the path of travel of switch actuating portion 32; and at the other position of element 24, the said other of projecting portions 30 and 31 is in the path of travel of actuating portion and the said one is then out of the path of travel thereof.

The operation of my novel and improved variable resistor and switch combination is briefly as follows. At the position of the elements shown in FIG. 1, movable switch element 24 is disposed to make contact between fixed switch contacts 13' and 12' and wiper arm 3 is disposed in full lines at a maximum resistance of resistive element 17. Upon movement of wiper arm 3 from its position in full lines to its position in dotted lines in FIG. 1, the resistance of resistive element 17 can be varied from maximum to minimum resistance. Upon completing approximately one complete revolution of 360° of wiper arm 3, switch actuating portion 32 of wiper arm 3 will engage projecting portion 31, as shown

in the dotted line position of wiper arm 3 in FIG. 1, to move switch element 24 from its position of FIG. 1 to its position of FIG. 2, whereby switch 4' breaks contact with fixed elements 13' and 12' and makes contact with fixed switch elements 14' and 12''. At this point, wiper arm 3 can continue a second revolution of approximately 360° in the same direction and move from its position shown in dotted lines in FIG. 2 to its position shown in full lines in FIG. 2 and again vary the resistance of resistive element 17 from a maximum to a minimum resistance. When wiper arm 3 has completed its second revolution of resistive element 17 in the same direction, actuating element 32 will engage projecting portion 30 and further movement of wiper arm 3 in that direction is stopped. Thereafter, wiper arm 3 is in a position to move in the opposite direction from a position of minimum resistance of resistive element 17, as shown in full lines of wiper arm 3 in FIG. 3, to a position of minimum resistance of resistive element 17 and then to *a* switch actuating position as shown in dotted lines of wiper arm 3 of FIG. 3 to actuate movable switch element 24 to its position shown in FIG. 4; and thereafter to again proceed through a second rotation in the same direction to its stopped position shown in full lines in FIG. 4.

Correlating the operation of the potentiometer or variable resistor 2, and switch 4' of FIGS. 1–4 to the circuit of FIG. 5, the following events occur. Initially, wiper arm 3 is disposed closer to movable switch element 24 which is the "off" position of potentiometer 2, at which position switch actuating portion 32 may engage projection portion 31. In the "off" position, the only possible current path from terminal A to terminal B of the circuit of FIG. 5 is through the silicon controlled rectifier 11 from its anode to cathode. Rectifier 11, however, is in a blocked condition because of no control voltage at its gate terminal. The blocking voltage of rectifier 11 is much higher than the peak line voltage appearing across it so that it is effectively an open circuit. As wiper arm 3 is rotated from its "off" position, wiper arm 3 engages resistive element 17 and causes a current to flow in the low voltage capacitor 9, causing it to charge and discharge with the fluctuations of the A.C. applied voltage. At the point in a half-wave charging cycle at which the voltage of capacitor 9 reaches the breakdown voltage of diode 8, diode 8 avalanches and discharges the capacitor 9 through the gate of rectifier 11 which in turn causes it to fire. This point in the positive half-wave charging cycle is determined by the position of wiper arm 3 in connection with resistive element 17 which can vary from maximum resistance to minimum resistance; and thereby the control can be set from a very small conduction angle of rectifier 11 to virtually full half-wave conduction of rectifier 11 during this first controlled rotation of wiper arm 3 in the direction shown in FIG. 1. At the end of this first rotation in the direction shown in FIG. 1, wiper arm 3 goes from minimum to an open circuit which stops all positive conduction of rectifier 11; and almost simultaneously, switch 4' is transferred to connect power diode 15 across the terminals A and B. This allows essentially full negative conduction through rectifier 15. Thus, the current value through lamp 1 can be varied from zero to one-half power through the control rectifier 11; and almost simultaneously, at the actuation of switch 4' from its position of FIG. 1 to its position of FIG. 2, the current value through the load is now essentially the same except for being negative instead of positive half-wave rectified D.C., which cannot be differentiated by the tungsten load in the way of light intensity. Wiper arm 3 can now proceed through a second rotation in the same direction, as shown in FIG. 2, and repeat the action of gradually increasing the positive half-wave component which together with the negative half-wave component provides at the maximum "on" position of the control, shown by the position of wiper arm 3 in FIG. 4.

essentially full power alternating current through lamp 1. Similarly, the reverse rotation of wiper arm 3 as shown in FIGS. 3 and 4 can vary the illumination of lamp 1 from its maximum "on" position first from maximum positive half-wave rectified D.C. through conduction of rectifier 11 to minimum conduction of rectifier 11, which in conjunction with the negative half-wave component through rectifier 15 provides a variation of light intensity from maximum to one-half power; and then, at the end of this first rotation in the direction shown in FIG. 3, switch element 24 is transferred to disconnect rectifier 15 across the terminals A and B which will cut off the negative component to lamp 1. Subsequently, a second rotation of the wiper arm 3 in contact with resistive element 17 now repeats the action of gradually decreasing the positive half-wave component, without any negative half-wave component, from full half-wave conduction of the positive component through rectifier 11 to minimum conduction of rectifier 11 and then to its "off" position.

Referring now to FIGS. 6 and 7, a more detailed embodiment of the variable resistor and switch combination shown schematically in FIGS. 1–4 is disclosed. FIG. 6 shows for the most part the resistor components thereof; and FIG. 7 shows for the most part the switch components thereof. Identifying numerals of FIGS. 6 and 7 shall be used in common with those previously used where particularly applicable.

Referring first to FIG. 6, the variable resistor and switch combination comprises a casing member 33 formed of a suitable non-conductive material. Positioned within member 33 is a terminal element 34 formed of conductive material and positioned in contact with wiper arm member 3 and providing an external terminal portion 35. Resistive element 17 is connected to casing member 33 at each of its ends 18 and 19 as shown with end 18 connected to terminal post member 36. Disc-like member 37 is an insulating and mounting disc connected to wiper arm member 3 by cooperating tabs 38 of arm 3 and notches 39 of disc 37. A switch actuating element associated with wiper arm 3 is indicated in FIG. 6 by the numeral 32′ and its actuating function correspond to the laterally projecting end 32 shown in FIGS. 1–4. Switch actuating element 32 or 32′ may be integral with wiper arm 3 as shown in FIGS. 1–4 or a separate element connected with wiper arm 3 and circumferentially disposed with respect to the contacting portions of arm 3 to actuate switch element 24 at the desired position of the contacting portions of wiper arm 3. Control arm 40 is mounted in a bearing member 41 which is rigid with casing member 33. The numeral 42 indicates a suitable gasket. Control arm 40 projects through casing member 33 to be keyed at its end portion 43 with disc 37; and control arm 40 projects through the central aperture of element 32′ and secured therewith by some suitable means. Rotation of control arm 40 provides for rotation of wiper arm 3, plate 37, and switch actuating element 32′ relative to casing member 33 and resistive element 17 secured to casing member 33.

Referring now to FIG. 7, the numeral 44 indicates a suitable housing member formed of non-conductive material. Connected to housing 44 are suitable terminal posts 45, 46 and 47 by conductive rivets 48, 49 and 50. The enlarged heads of rivets 49 and 50 form fixed switch contact elements 51 and 52, which are equivalent to the fixed switch contact elements 13 or 13′ and 14 or 14′, previously identified. Rivet 48 mounts a movable switch contact member 53, which in turn is conductively connected by rivet 48 to the external post 45. Movable switch contact element 53 is equivalent to movable contact 12 of FIG. 5 or to fixed contacts 12′ and 12″ and contacting portion 25 of FIGS. 1–4. Contact element 53 is carried for movement between fixed contacts 51 and 52 by mounting member 54, which is formed of non-conductive material and which is mounted for swinging movemens on post 55. Post 55 is mounted at its end 56 in boss 57 of housing member 44.

A switch actuating member 57 is also mounted on post 55 adjacent plate 54. A spring 58 has its end 59 connected to tip 60 of member 57 and its other end 61 mounted on post 62 of mounting member 54. Spring 58 biases member 57 to an off dead-center position; and upon movement of actuating member 57 through dead center, it actuates movement of mounting member 54, which in turn will move switch element 53 between fixed contacts 51 and 52. Housing 44 has a stop portion 63 disposed between ears 64 and 65 of member 57 which is equivalent to the stops 27 and 28 of FIGS. 1–4. Projecting ears 66 and 67 of member 57 are equivalent to projecting portions 30 and 31 of FIGS. 1–4; and spring 58 is generally the equivalent of spring 59 shown in FIGS. 1–4. A casing member 68 is connected to housing member 44 by any suitable means, as for example by rivets 69 and 70 to enclose the switch elements of FIG. 7; and member 68 has projecting tabs 71 which connect casing member 33 therewith to bind the components of the combination potentiometer or variable resistor and switch together. Member 68 has an aperture 72 through which that part of element 57 carrying projecting ears 66 and 67 projects; and whereby, ears 66 and 67 are disposed to be actuated by tip 73 of actuating element 32′. Ears 66 and 67 are disposed in relation to tip 73 so that at one position of member 57, one of the ears 66 and 67 is in the path of travel of tip 73 and the other is out of the path of travel of tip 73, and at the other position of member 57, the other of the ears 66 and 67 is in the path of travel of tip 73 and the said one of ears 66 and 67 is out of the path of travel thereof. This is equivalent to the operation of projecting portions 30 and 31 and actuating element 32 of FIGS. 1–4, hereinbefore described.

It might be mentioned that although the combination potentiometer or variable resistor and switch structure of FIGS. 6 and 7 shows a single pole double throw switch arrangement, particularly suited to the circuit of FIG. 5, some applications of my invention might require only a single pole single throw switch or some other suitable switch combination. By way of example, a single pole single throw switch arrangement would be suitable in a circuit similar to FIG. 5 but eliminating diode 16 and wherein switch element 12 would move only into or out of contact with a fixed contact 14.

My novel and improved variable resistor and switch combination has been thoroughly tested and found to be completely satisfactory for the accomplishment of the objectives set forth; and, while I have shown and described a particular embodiment and application thereof, it will be understood that the same is capable of modification and other application without departure from the spirit and scope of my invention, as defined in the claims.

What I claim is:

1. A variable resistor and switch combination comprising a longitudinally extended resistive element generally circularly disposed with its opposite ends spaced apart and having at least one end connected to a conductor terminal, a wiper arm mounted for rotation about the axis of the resistive element and having its radially outwardly disposed end portion in conductive contact with said resistive element and said end portion being connected to a second conductor terminal to provide a variable resistance between said conductor terminals upon rotation of the wiper arm, means for controlling the movement of said wiper arm whereby said wiper arm is free for rotation in one direction for approximately 720° and to rotate twice around said resistive element, after movement twice around said resistive element in one direction further movement of said wiper arm is stopped and said wiper arm is free for rotation in the opposite direction approximately 720° and for movement twice around said resistive element in said opposite direction, and then further movement of said wiper arm in said opposite direction is stopped; a switch comprising a fixed contact element

and a movable contact element; means for actuating the movement of said movable contact element into and out of contact with said fixed element in relation to the position of said wiper arm, whereby said movable element is moved into contact with said fixed element upon the rotation of said wiper arm in one direction and at the place of movement of said wiper arm from a position completing one rotation around said resistive element and prior to the commencement of a second rotation around said wiper arm in one direction and whereby said movable element is moved out of contact with said fixed element upon the rotation of said wiper arm in the opposite direction and at the place of movement of said wiper arm from a position completing one rotation around said resistive element and prior to the commencement of a second rotation around said resistive element in said opposite direction.

2. A variable resistor and switch combination comprising a longitudinally extended resistive element generally circularly disposed with its opposite ends spaced apart and having at least one end connected to a conductor terminal, a wiper arm mounted for rotation about the axis of the resistive element and having its radially outwardly disposed end portion in conductive contact with said resistive element and said end portion being connected to a second conductor terminal to provide a variable resistance between said conductor terminals upon rotation of the wiper arm, said wiper arm having a switch actuating element carried thereby for movement therewith, a switch comprising a fixed contact element and a generally toggle-acting movable switch contact element, said movable switch element being mounted adjacent said resistive element for limited pivotal swinging movements between a switch closed position in contact with fixed switch element and a switch open position out of contact with said fixed switch element, said movable switch element comprising a pair of laterally spaced projecting portions disposed in the path of travel of said switch actuating element whereby at one position of said movable switch element one projecting portion is in the path of travel of said switch actuating element and the other projecting portion is out of the path of travel of said switch actuating element and at the other position of said movable switch element the other projecting portion is in the path of travel of said switch actuating element and the other projecting portion is out of the path of travel thereof, means limiting the movement of said movable switch element between its two positions, said wiper arm and said switch actuating element carried thereby being free to rotate except as said wiper arm may be stopped by engagement of said switch actuating element with said movable switch element, upon each rotation of said wiper arm, said switch actuating element will engage one of the projecting portions of the movable switch element, upon one rotation of said wiper arm in one direction said switch actuating element will engage one of the projecting portions of the movable switch element to actuate the movable switch element from one position to its other position and upon the next rotation of said wiper arm around said resistive element in the same direction said switch actuating element will engage the other projecting portion to prevent further rotation of said wiper arm in said one direction, whereby, said wiper arm is free for rotation in one direction for approximately 720° and to rotate twice around said resistive element with said movable switch element being actuated between its open and closed positions at a point approximately midway between the path of travel of said wiper arm in said one direction, after movement twice around said resistive element in one direction further movement of said wiper arm is stopped and said wiper arm is free for rotation in the opposite direction approximately 720° and for movement twice around said resistive element in said opposite direction with said movable switch element being actuated at a point approximately midway in the path of travel of said wiper arm in said opposite direction, and then further movement of said wiper arm in said opposite direction is stopped with the wiper arm then being free for rotation again in said one direction.

No references cited.