

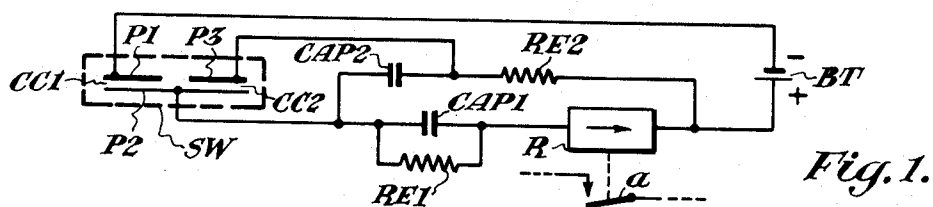
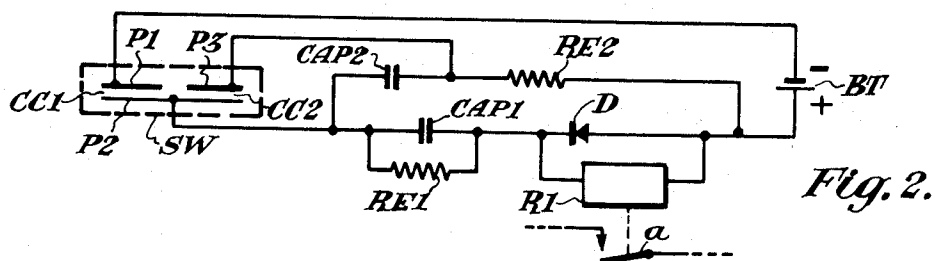
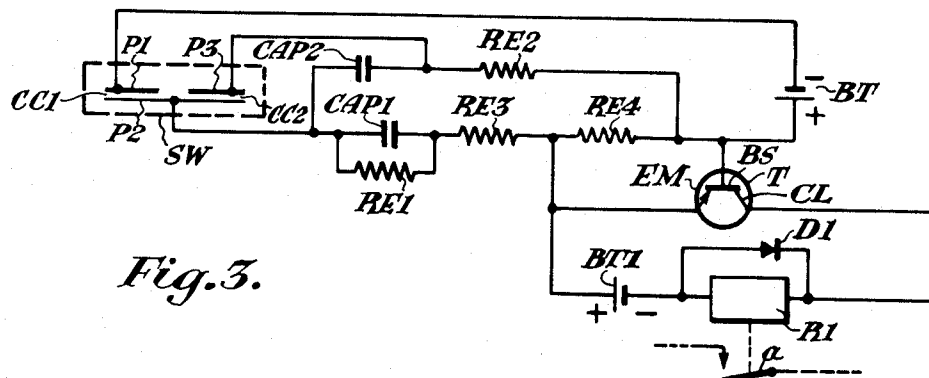
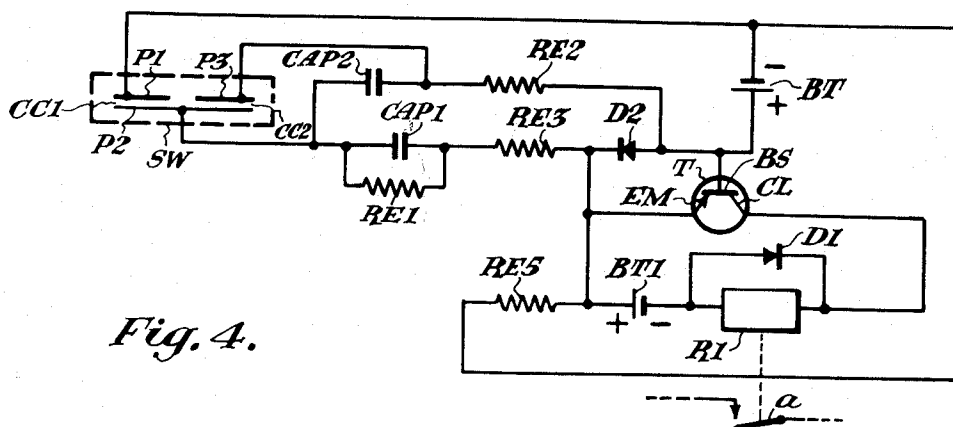
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ELECTRICAL CONTROL APPARATUS

Filed July 26, 1962



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ELECTRICAL CONTROL APPARATUS

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My invention pertains to electrical control apparatus, and particularly to apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers. More specifically my invention pertains to apparatus for actuating a relay or other device in response only to a predetermined sequence of closure of first and second sets of contacts regardless of whether said sequential closure of the contacts occurs in an overlapping or non-overlapping manner.

There are many electrical control systems in which it is desired that a relay or other electrically controlled device will be actuated only in response to a preselected sequence of actuation of first and second circuit controllers. For example, in a system for recording the number of road vehicles passing in a predetermined direction only through a double direction vehicle traffic section of roadway having sufficient clearance for the width of only a single vehicle at a time, it is oftentimes the practice to provide a wheel actuated switch or treadle in such section of roadway so that the treadle will be depressed by the wheels of each vehicle passing through the roadway section. In order that the vehicle recording system will record only the vehicle passing in said predetermined direction through the section of roadway, it is necessary to determine the direction of passage of each vehicle before the recording system is or is not actuated as the case may be. A single treadle-actuated set of contacts or circuit controller is not usually employed in such a vehicle recording system because such a single set of contacts or circuit controller cannot be made directionally responsive without a relatively complex mechanical latching arrangement to prevent the set of contacts from being actuated when a wheel of a vehicle passes over the treadle in the non-recording direction. Accordingly, it is the usual practice to provide two successive treadles each having a single set of contacts, or a single treadle having two sets of contacts so arranged as to be actuated in a sequence according to the direction of passage of a vehicle wheel over the single treadle. In conjunction with such contacts or circuit controllers it has heretofore been the practice to employ a group of relays which are selectively responsive to the direction of passage of the vehicles, that is, to the sequence of actuation of said sets of contacts or circuit controllers. Contacts of the relays are employed to control the operation or to prevent the operation of the recording system as the case may be. For obvious economic reasons it would be desirable to employ less costly devices than relays for determining the direction of passage of the vehicles past the vehicle recording point.

It is, therefore, an object of my invention to provide improved electrical control apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers and employing a minimum of relays.

It is a second object of my invention to provide apparatus such as that set forth above and which operates in the desired manner regardless of whether the sequential actuation of the circuit controllers is an overlapping or non-overlapping type of actuation.

Another object of my invention is to provide apparatus such as that described above and which will operate in the desired manner in response to a relatively briefer period of closure of the circuit controller contacts than the apparatus heretofore employed.

In accomplishing the above objects of my invention I

employ a pair of energy storing devices or capacitors in conjunction with the sequentially actuated circuit controllers, and provide a circuit arrangement whereby energy is stored in one of said capacitors upon the actuation of a first of said circuit controllers and is thereafter discharged to operate a relay or other electrically responsive device upon the actuation of the second circuit controller. In modifications of such apparatus I employ an electronic switching device, such as a transistor, to provide greater sensitivity for operation of said relay or other electrically responsive device.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I will describe four forms of apparatus embodying my invention and will then point out the novel features thereof in claims.

In the accompanying drawings:

FIG. 1 is a diagrammatic view showing one form of apparatus embodying my invention and employing a polar biased relay which is energized in response to a predetermined sequence of actuation of first and second circuit controllers.

FIG. 2 is a diagrammatic view of an alternate form of the apparatus of FIG. 1 in which the polar biased relay of FIG. 1 is replaced by a conventional neutral relay having a diode connected in multiple with the relay winding.

FIG. 3 is a diagrammatic view of a third form of apparatus embodying my invention and employing an electronic switching device or transistor to control the energization of a neutral relay such as employed in FIG. 2.

FIG. 4 is a diagrammatic view of an alternate form of the apparatus of FIG. 3 employing the electronic switching device or transistor shown in FIG. 3, and an additional diode and control circuitry.

Similar reference characters refer to similar parts in each of the views.

Referring first to FIG. 1, there is shown at the left hand side thereof, a switch designated SW and comprising first and second sets of contacts or circuit controllers designated CC1 and CC2, respectively. Circuit controller CC1 includes a resilient leaf or contact plate P1 which when actuated in a downward direction as viewed on the drawing, makes physical contact with a contact plate P2 so that an electrical circuit may be completed between plates P1 and P2. Similarly, circuit controller CC2 includes a resilient leaf or contact plate P3 which when actuated in a downward direction makes physical contact with plate P2 so that an electrical circuit may be completed between plates P3 and P2.

As previously discussed, switch SW may be considered to be a treadle actuated switch arranged to be depressed by the wheels of a vehicle passing thereover so that circuit controllers CC1 and CC2 are actuated to contact closing conditions in a sequence according to the direction of passage of the vehicle wheels. Such treadle actuated switches are well known and it is to be understood that the details of switch SW form no part of my invention, but that the invention is intended to operate in response to a predetermined sequence of operation to contact closing conditions of any type of first and second circuit controllers. For example, circuit controllers CC1 and CC2 could each be a spring return push button which must be manually actuated in a predetermined sequence for the proper response of the apparatus of my invention, or any other type of circuit controllers intended to be actuated in a sequential manner could be employed. As heretofore pointed out and as pointed out in more detail hereinafter, it is immaterial to the operation of my invention whether controllers CC1 and CC2 are sequentially actuated to circuit closing conditions in an overlapping or non-overlapping manner.

Referring further to FIG. 1, there is shown, in the conventional manner, first and second energy storing devices or capacitors CAP1 and CAP2, first and second resistors RE1 and RE2, and a battery BT having its positive and negative terminals designated by the conventional symbols + and -, respectively.

A polar biased relay designated by the reference character R is shown in the drawing by a rectangle representing the winding of the relay. The arrow enclosed in the rectangle representing such winding indicates the direction of the biasing of the relay, that is, the direction in which positive current must flow through the relay winding to cause the contacts of the relay to become picked up. It is thus apparent that the flow of current through the winding of the relay must be from left to right, as viewed on the drawing, to cause pickup of the relay contacts. Such biased relays are well known in the electrical art. A normally open contact *a* is shown below the rectangle representing the relay winding and is indicated as controlled thereby by the dotted line extending from such rectangle to the movable part of the contact. It will, therefore, be readily understood that contact *a* is actuated to a circuit closing position only when current flows through the winding of the relay in the direction from left to right. The specific circuits controlled by contact *a* of relay R (as well as the circuits controlled by contacts *a* of relays R1 of FIGS. 2, 3 and 4) are not shown in the drawing since they form no part of my invention, but it is to be understood that such contact may be employed to control any desired type of indication or control circuits, or an electrically actuated counter or other such device.

The positive terminal (+) of battery BT is connected in multiple to the right hand side of the winding of relay R and a first end of resistor RE2. The left hand side of the winding of relay R is connected in multiple to one side of capacitor CAP1 and a first end of resistor RE1. The second end of resistor RE2 is connected in multiple to a first side of capacitor CAP2 and to contact plate P3 of circuit controller CC2. The second sides of capacitors CAP1 and CAP2 and the second end of resistor RE1 are connected in multiple with each other and to contact plate P2 which is common to both controllers CC1 and CC2. Contact plate P1 of controller CC1 is connected to the negative terminal (-) of battery BT.

It should be pointed out at this time that resistor RE1 is employed for discharging or "bleeding" capacitor CAP1, under conditions hereinafter described, and has a high resistance so that it normally draws little current. It should also be pointed out that capacitors CAP1 and CAP2, resistor RE2, and the resistance of the winding of relay R are proportioned so that if circuit controller CC1 only is actuated to its circuit closing position at any time, capacitor CAP2 will be charged, over the circuits to be hereinafter discussed, to at least as high a voltage as capacitor CAP1. For reasons which will be made apparent in the following discussion, the charging of capacitor CAP2 under such conditions will, when controller CC1 thereafter returns to its unactuated position, prevent the improper energization of relay R.

The apparatus of FIG. 1 operates in the following described manner.

(1) Actuation of circuit controller CC1 followed by actuation of circuit controller CC2 (termed normal sequence of operation):

When controller CC1 is actuated, current will flow over a circuit which may be traced from the positive terminal (+) of battery BT, winding of relay R, right hand side of capacitor CAP1, left hand side of CAP1, contact plate P2, contact plate P1, and thence to the negative terminal (-) of battery BT. At the same time current also flows from the positive terminal of battery BT, through resistor RE2, capacitor CAP2, and

thence to contact plate P2, contact plate P1 and over the remainder of the circuit traced above. Capacitors CAP1 and CAP2 become charged by such flow of current but relay R remains released since the current flow through the winding of the relay is in the direction from right to left.

If circuit controller CC2 is actuated before controller CC1 returns to its unactuated position, the following operation of the apparatus occurs.

The actuation of CC2 immediately discharges capacitor CAP2 over an obvious circuit including contact plates P2 and P3 of switch SW. At the same time the positive terminal of battery BT is connected to the negative terminal of the battery through resistor RE2 and over contact plates P3, P2 and P1 of switch SW, but such closed circuit produces no action and resistor RE2 prevents a direct short circuit of the battery at such time. When controller CC1 thereafter returns to its unactuated position and opens the circuit through contact plates P1 and P2, capacitor CAP1 will start to discharge through the winding of relay R in the direction from left to right, and through resistor RE2 and contact plates P3 and P2. If controller CC2 returns to its unactuated position before capacitor CAP1 is discharged, the charge on capacitor CAP1 will continue to flow through the winding of the relay R in the same direction and will charge capacitor CAP2 until the two capacitors have an equal charge. Relay R thus becomes picked up by the current flowing through the relay winding in the direction from left to right, even though the actuation of controller CC2 to its contact closing position is of extremely short duration.

If circuit controller CC2 is actuated after controller CC1 returns to its unactuated position, the following operation of the apparatus takes place.

The actuation of CC2 to its contact closing position immediately discharges capacitor CAP2 and also starts the discharge of capacitor CAP1 through relay R in the direction from left to right over the previously mentioned circuit including resistor RE2 and contact plates P2 and P3 of switch SW. As discussed above, if circuit controller CC2 returns to its unactuated position before capacitor CAP1 is discharged, the charge on capacitor CAP1 will continue to flow through relay R in the same direction until the charge on capacitor CAP2 equals that on capacitor CAP1. Relay R thus becomes picked up in response to the energy flowing through the relay winding in the direction from left to right.

(2) Actuation of circuit controller CC2 followed by actuation of circuit controller CC1 (termed reverse sequence of operation):

When controller CC2 is actuated, no resultant operation of the apparatus occurs since there is no charge on capacitors CAP1 and CAP2. When controller CC1 is thereafter actuated, capacitor CAP1 is charged, as previously described, with the direction of current from right to left through the winding of relay R. When controller CC2 returns to its unactuated position, capacitor CAP2 becomes charged thus making the charges on the two capacitors equal. When controller CC1 thereafter returns to its unactuated position, capacitor CAP1 discharges relatively slowly through resistor RE1. At the same time capacitor CAP2 discharges relatively slowly through resistor RE2, the winding of relay R, and resistor RE1. The direction of current through the winding of relay R is, at such time, from right to left and the relay remains released. It is, therefore, readily apparent that for sequential circuit controller operation CC2-CC1 all the current through the winding of relay R is in the direction from right to left and the relay remains released.

As previously mentioned, if controller CC1 only is actuated at any time, capacitors CAP1 and CAP2 will become equally charged so that, upon the opening of contact plates P1 and P2, no current will flow from capaci-

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tor CAP1 through the winding of relay R in a direction to cause pickup of the relay. The energy stored in capacitors CAP1 and CAP2 under these conditions will, after the opening of P1 and P2, discharge through resistor RE1 as described above.

It is obvious that if controller CC2 only is actuated at any time no operation of the apparatus takes place since no circuit is completed to battery BT at such time.

By the foregoing discussion it will be readily understood that relay R is actuated, that is, becomes picked up when and only when circuit controllers CC1 and CC2 of switch SW are sequentially actuated, in that order, to their circuit closing positions.

Referring to FIG. 2 of the drawings, the apparatus is identical to that of FIG. 1 except that relay R of FIG. 1 is replaced by a neutral (unbiased) relay R1 having an asymmetric unit or diode D connected across the winding of the relay so that, when controller CC1 is actuated, the positive energy from battery BT can flow through diode D, in the low resistance direction thereof, to charge capacitor CAP1. Thus, relay R1 will remain released at such time. However, when capacitor CAP1 is discharging, as previously discussed in connection with FIG. 1, the energy from capacitor CAP1 will flow through the winding of relay R1, due to the high resistance of diode D to such direction of current flow, and relay R1 will become picked up. It is, therefore, readily apparent that the apparatus of FIG. 2 and the operation of such apparatus is, with the exceptions set forth identical to that of FIG. 1, and no further discussion of the details of such apparatus and its operation are believed necessary.

Referring now to FIG. 3, the apparatus arrangement is similar to that of FIG. 2 with the following exceptions. In place of diode D and the winding of relay R1, two series connected resistors RE3 and RE4 are connected between the positive terminal (+) of battery BT and the first side of capacitor CAP1. An electronic switching device here shown as a PNP type transistor T is provided and has its base BS connected to the positive terminal of battery BT and its emitter EM connected to the series connection between resistors RE3 and RE4. The collector CL of transistor T is connected to a first side of the winding of relay R1, which is similar to relay R1 of FIG. 2. A second battery designated BT1 is provided and the negative terminal (-) of battery BT1 is connected to the second side of the winding of relay R1. The positive terminal (+) of battery BT1 is connected to emitter EM of transistor T. An asymmetric unit or diode D1 is connected across the winding of relay R1 with the low resistance direction of the diode being in a direction from said second side of relay R1 to said first side of the relay. Diode D1 is provided in the modification of FIG. 3 (as well as in the modification of FIG. 4 discussed below) only to protect transistor T from the energy induced in the winding of relay R1 when the relay becomes deenergized. Such arrangement is well known and it is readily apparent that diode D1 dissipates the energy induced across the winding of relay R1, without such energy flowing through the emitter to collector circuit of transistor T.

The apparatus of FIG. 3 operates similarly to that of FIGS. 1 and 2 for the different sequences of actuation of circuit controllers CC1 and CC2, except as set forth below.

Under normal conditions as shown in FIG. 3, that is, with both controllers CC1 and CC2 unactuated, transistor T is nonconducting, as is obvious. Relay R1 is, therefore, normally released since no current is flowing in the emitter to collector circuit of transistor T at such time. Similarly, when capacitor CAP1 is being charged from battery BT, under the conditions of actuation of controllers CC1 and CC2 previously discussed in connection with FIGS. 1 and 2, transistor T is nonconducting since the base BS of transistor T is, due to the voltage drop across resistor RE4 at such time, at a more positive po-

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tential than emitter EM of the transistor. That is to say, transistor T is reverse biased at such time and, therefore, negligible current flows through the emitter to collector circuit of the transistor and relay R1 remains released while capacitor CAP1 is being charged. When capacitor CAP1 is discharging through controller CC2 or into capacitor CAP2, the discharge path is through resistor RE3 and over parallel paths comprising resistor RE4 and the emitter-base junction of transistor T, then through resistor RE2. At such time the emitter EM of transistor T becomes more positive than the base BS of the transistor and current from the positive terminal of battery BT1 flows through the emitter to collector circuit and the winding of relay R1 to the negative terminal of battery BT1. This causes relay R1 to become picked up and front contact a of the relay closes. It is thus apparent that the apparatus of FIG. 3 operates in a manner similar to that of FIGS. 1 and 2. The inclusion of the electronic switch or transistor T provides greater sensitivity of operation of the apparatus, and the energy handled by the capacitors may be much smaller thus permitting the use of smaller components.

The apparatus of FIG. 4 is similar to that of FIG. 3 except that resistor RE4 of FIG. 3 is replaced by a diode D2, and emitter EM of transistor T is connected through a resistor RE5 to the negative terminal of battery BT. By this arrangement, in the normal condition of the apparatus as shown in FIG. 4, that is, with neither controller CC1 or CC2 actuated, transistor T is in the reverse-biased or cut-off condition due to the voltage drop across diode D2 in the circuit extending from the positive terminal of battery BT, through diode D2 in its low resistance direction, and through resistor RE5 to the negative terminal of battery BT. When capacitor CAP1 is discharging either through controller CC2 in its actuated position, or into capacitor CAP2, the major portion of the current flows through resistor RE3, then flows through the emitter-base junction of transistor T and through resistor RE2. Only a negligible amount of such current will flow through the two paths in parallel with the emitter-base junction, that is (1) through diode D2 in its high resistance direction and (2) through resistor RE5 (which is selected to be relatively high resistance) and battery BT. Since the major portion of capacitor CAP1 discharge current flows through the emitter-base junction of transistor T, the transistor is held in the conducting condition through its emitter to collector circuit at lower levels of current from capacitor CAP1 than in the arrangement of FIG. 3. Relay R1 becomes picked up at such time over the circuit extending from the positive terminal of battery BT1, emitter to collector circuit of transistor T, and through the winding of the relay to the negative terminal of battery BT1. It is thus apparent that the apparatus of FIG. 4 operates in a manner similar to that of FIG. 3 but that diode D2 forces the major part of capacitor CAP1 discharge current through the emitter-base junction of transistor T and, since transistor T is held in the conducting condition (emitter to collector) at lower levels of current from capacitor CAP1 than in the arrangement of FIG. 3, it is capable of operation with less energy stored in capacitor CAP1. Thus, the system of FIG. 4 will operate for shorter periods of closure of controller CC1 than will the system of FIG. 3.

Apparatus such as herein disclosed is relatively simple and reliable and provides more positive operation, under conditions of relatively short closures in a preselected sequence of the contacts of first and second circuit controllers, than the relay systems heretofore employed for such purpose.

Although I have herein shown and described only four forms of apparatus embodying my invention, it will be understood that various changes and modifications may be made therein within the scope of the appended claims

without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. Means for detecting a predetermined sequence of actuation to circuit closing positions of first and second normally open circuit controllers, said means, comprising, in combination:
 - (a) a capacitor,
 - (b) a source of direct current energy,
 - (c) electrical contact controlling means actuated only when direct current energy is supplied thereto in a predetermined direction,
 - (d) first circuit means responsive to an actuation of said first circuit controller prior to an actuation of said second circuit controller for supplying direct current energy from said source to said contact controlling means in a direction opposite to said predetermined direction and at the same time to said capacitor for charging thereof, and
 - (e) second circuit means responsive thereafter to an actuation of said second circuit controller for discharging said capacitor through said contact controlling means in said predetermined direction.
2. In combination:
 - (a) first and second normally open circuit controllers each actuatable to a circuit closing position,
 - (b) a source of direct current energy,
 - (c) contact actuating means having first and second terminals and a contact actuatable to a closed position only when said first and second terminals are connected to the positive and negative terminals of a source of direct current energy,
 - (d) first and second electrical energy storing devices,
 - (e) first circuit means connecting the positive terminal of said energy source to the positive terminal of said contact actuating means and the negative terminal of such actuating means to a first side of said first energy storing device,
 - (f) a resistor,
 - (g) second circuit means connecting the positive terminal of said energy source to one side of said resistor and the other side of said resistor to a first side of said second energy storing device,
 - (h) third circuit means responsive to an actuation of said first circuit controller for connecting the second sides of said first and second energy storing devices to the negative terminal of said energy source to charge said devices, and
 - (i) fourth circuit means thereafter responsive to an actuation of said second circuit controller for instantaneously discharging said second energy storing device.
3. In combination:
 - (a) first and second normally open circuit controllers each actuatable to a circuit closing position,
 - (b) first and second electrical energy storing devices,
 - (c) a source of direct current energy,
 - (d) a relay magnetically biased to a first position and actuatable to a second position only when the positive and negative terminals of a source of direct current energy are connected to first and second terminals respectively of the relay,
 - (e) a resistor,
 - (f) a first electrical conductor connecting the positive terminal of said energy source to said second terminal of said relay and to one end of said resistor,
 - (g) a second electrical conductor connecting said first terminal of said relay to one side of said first energy storing device,
 - (h) a third electrical conductor connecting the other end of said resistor to one side of said second energy storing device,
 - (i) circuit means responsive to an actuation of said first circuit controller to its closed position for connecting the other sides of both said energy storing

devices to the negative terminal of said energy source, and

- (j) other circuit means responsive to an actuation of said second circuit controller to its closed position for connecting said other end of said resistor and said one side of said second energy storing device to said other sides of both said energy storing devices.
4. Apparatus responsive only to a predetermined sequence of contact closing actuation of first and second circuit controllers having normally open contacts, said apparatus comprising, in combination:
 - (a) a relay having a winding requiring direct current therethrough in a predetermined direction for pickup of the contacts of the relay,
 - (b) a capacitor connected in a series circuit with the winding of said relay,
 - (c) a source of direct current,
 - (d) circuit means responsive to an actuation of said first circuit controller prior to an actuation of said second circuit controller for supplying direct current from said source to said series circuit in a direction opposite to said predetermined direction, and
 - (e) circuit means thereafter responsive to the actuation of said second circuit controller for discharging said capacitor through the winding of said relay in said predetermined direction.
 5. Apparatus responsive only to a predetermined sequence of operation of first and second circuit controllers, said apparatus comprising, in combination:
 - (a) a relay having a winding requiring current therethrough in a predetermined direction for pickup of the relay,
 - (b) a capacitor,
 - (c) a source of direct current,
 - (d) means responsive to an operation of said first circuit controller prior to an operation of said second circuit controller for charging said capacitor with direct current flowing from said source through the winding of said relay in a direction opposite to said predetermined direction, and
 - (e) means thereafter responsive to an operation of said second circuit controller for discharging said capacitor through the winding of said relay in said predetermined direction.
 6. Apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:
 - (a) a relay having a winding requiring current of a first polarity therethrough for actuation of the relay,
 - (b) a capacitor connected in series with said winding,
 - (c) means responsive to an actuation of said first circuit controller prior to an actuation of said second circuit controller for supplying current of a second polarity to said winding and said capacitor, and
 - (d) means thereafter responsive to an actuation of said second circuit controller for discharging said capacitor through said winding.
 7. Apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:
 - (a) a capacitor,
 - (b) means responsive to an actuation of said first circuit controller prior to an actuation of said second circuit controller for charging said capacitor,
 - (c) means thereafter responsive to an actuation of said second circuit controller for discharging said capacitor, and
 - (d) a relay energized in response to said discharging of said capacitor.
 8. Apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:
 - (a) an energy storage device,
 - (b) means responsive to an actuation of said first cir-

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cuit controller prior to an actuation of said second controller for charging said energy storage device,

(c) means thereafter responsive to an actuation of said second controller for discharging the energy stored in said storage device, and

(d) a relay connected to be energized in response to the discharge of said energy.

9. Apparatus for energizing a relay only in response to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:

(a) a source of direct current,

(b) first and second energy storing devices,

(c) means responsive to an actuation of said first circuit controller prior to an actuation of said second circuit controller for charging said energy storing devices from said source of current,

(d) means thereafter responsive to an actuation of said second circuit controller for immediately discharging said second energy storing device, and

(e) means thereafter responsive to the return of said circuit controllers to their unactuated condition for discharging said first energy storing device into said second storing device and for energizing said relay in response to the discharge of such first device.

10. Apparatus for energizing a relay only in response to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:

(a) a first source of direct current energy,

(b) an energy storing device,

(c) means responsive to an actuation of said first circuit controller for charging said energy storing device from said source of energy,

(d) means thereafter responsive to an actuation of said second circuit controller for discharging said energy storing device,

(e) a normally nonconducting electronic switching device connected to be switched to a conducting condition by the discharge of energy from said energy storing device,

(f) a second source of direct current energy, and

(g) circuit means for energizing said relay from said second source of energy in response to the switching of said electronic device to the conducting condition.

11. Apparatus responsive only to a predetermined sequence of actuation of first and second circuit controllers, said apparatus comprising, in combination:

(a) an energy storing device,

(b) means responsive to an actuation of said first circuit controller for storing energy in said device,

(c) means thereafter responsive to an actuation of said second circuit controller for discharging the energy stored in said device,

(d) a normally nonconducting electronic switching device connected to be switched to a conducting condition by the discharge of energy from said energy storing device, and

(e) an electrically actuated device connected to be

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energized in response to the switching of said electronic device to a conducting condition.

12. In combination:

(a) first and second sets of normally open contacts each set actuatable to a circuit closing condition,

(b) first and second capacitors,

(c) a source of direct current energy,

(d) means including said source of energy for charging said capacitors in response to an actuation of said first set of contacts prior to an actuation of said second set of contacts,

(e) means thereafter responsive to an actuation of said second set of contacts for immediately discharging said second capacitor,

(f) means including said second capacitor for discharging said first capacitor in response to the return of said first and second sets of contacts in that order to their normal condition, and

(g) a relay connected to be energized in response to said discharging of said first capacitor.

13. In combination:

(a) first and second circuit controllers each having a set of contacts in a normally open condition and actuatable to a circuit closing condition,

(b) first and second capacitors,

(c) a first source of direct current energy,

(d) means including said source of energy for charging said capacitors in response to an actuation of said first circuit controller prior to an actuation of said second circuit controller,

(e) means thereafter responsive to an actuation of said second circuit controller for immediately discharging said second capacitor;

(f) means including said second capacitor, and further thereafter responsive to the return of said first and second circuit controllers in that order to their normally open contact condition, for discharging said first capacitor;

(g) a normally nonconducting electronic switching device connected to be switched to a conducting condition in response to said discharging of said capacitor,

(h) a second source of direct current energy,

(i) a relay, and

(j) circuit means including said second source of energy for energizing said relay in response to the switching of said electronic device to the conducting condition.

14. Apparatus in accordance with claim 13 and in which said electronic switching device comprises a PNP type transistor.

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