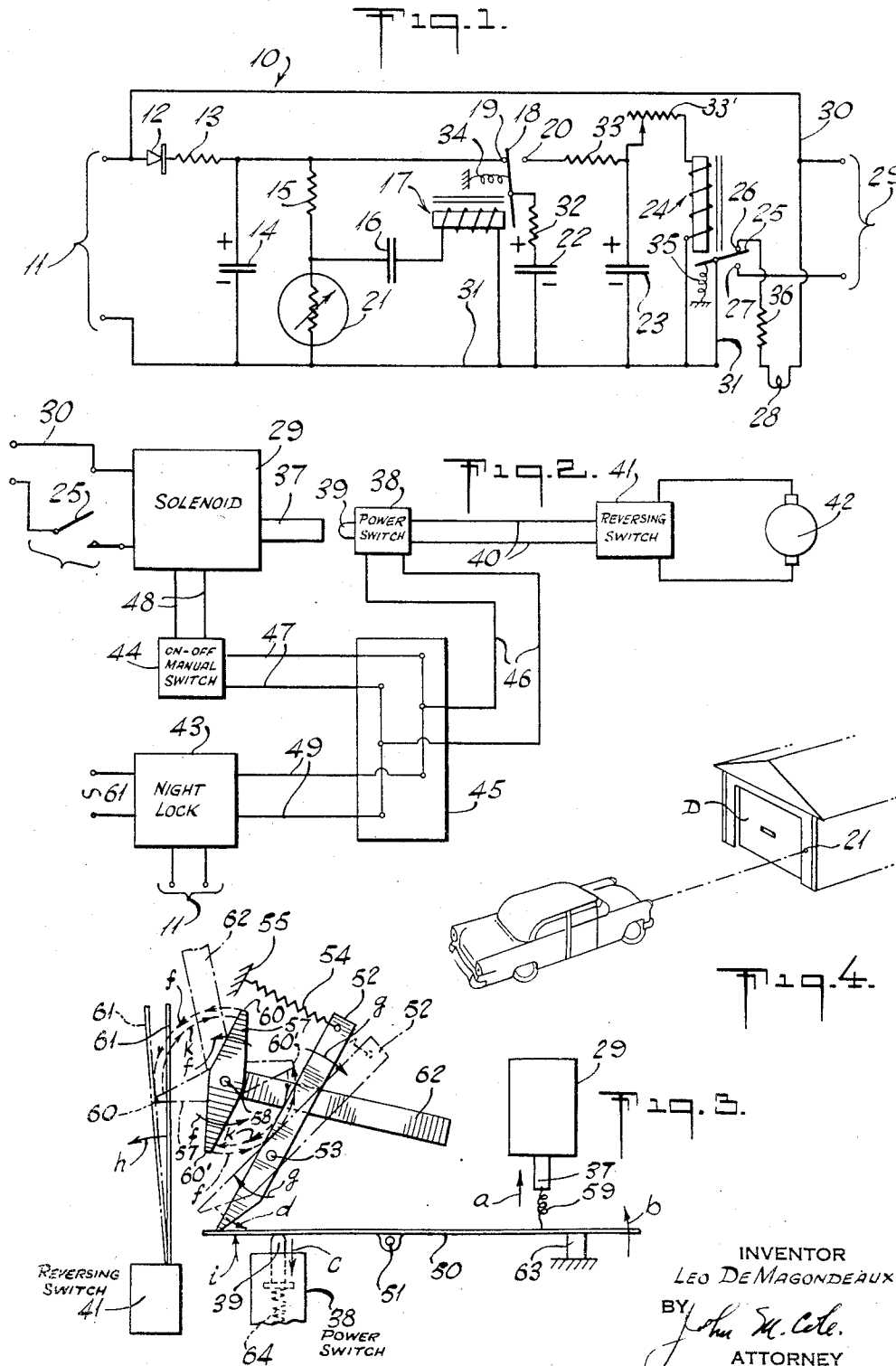


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ELECTRICAL CONTROL RESPONSIVE TO
SUCCESSIVE CIRCUIT INTERRUPTIONS
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ELECTRICAL CONTROL RESPONSIVE TO SUCCESSIVE CIRCUIT INTERRUPTIONS

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6 Claims. (Cl. 268—1)

The present invention relates to electrical control responsive to successive circuit interruptions, and, in particular, to a remote control relay circuit responsive to intermittent signals and accommodating switching apparatus therefor.

The invention may be employed for a variety of applications. However, for the purpose of illustration, the invention will be disclosed in a light-responsive remote control circuit for actuating garage doors and the like.

Remote control light-responsive systems now in use to open or close garage doors utilize a continued illumination of a photocell to actuate the same. Unfortunately, such systems are also responsive to spurious signals such as sunlight, lights reflected by passing traffic, flash lights, or the light beam of a standing automobile in front of the garage. In the latter instance, the garage doors are set into motion when the car lights are turned on, even though the driver has no intention of actuating the garage door. On the other hand, the control system employing the instant invention responds only to repeated or immediately successive light signals, i. e., a light that flashes on and off several times before the remote control system sets the garage door into motion. Thus, the problems of spurious signals are avoided.

Furthermore, by substituting pressure-sensitive, or an infra-red or other heat-sensitive element, in place of a light-responsive cell, the invention may be incorporated into a remote control or signaling system having a wide variety of applications.

Accordingly, it is the principal object of the instant invention to provide a remote control or signaling system responsive to emission of such flashes of light, or heat rays, or pressure fronts. The system provides a triggering signal in response to the repetitive, or successive, rays of light, heat or pressure fronts, which signal may be used to actuate heavy-duty power-operated apparatus or other load utilization circuit.

It is a further object of this invention to provide a remote control or signaling system having a wide variety of applications because it is readily adaptable to be used with vibratory or oscillatory responsive elements, including, without limitation, light-sensitive, heat-sensitive, or pressure-sensitive elements in the signal-generating circuit thereof to initiate the generation of its control signal.

It is a further object of this invention to provide a remote control or signaling system capable of distinguishing between the emission of uninterrupted rays of light, heat or pressure fronts from a series of repetitive rays of light, heat or pressure fronts. In carrying out this object, a light, heat or pressure-sensitive element is shunted across a primary charging circuit having capacitor-relay components. Upon energizing the responsive element by repetitive signals, a capacitor element is correspondingly disconnected from the primary circuit and connected to a secondary capacitor-relay circuit to charge the latter. The discharge of the secondary circuit generates the output control signal of the system.

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It is a further object of the instant invention to provide a garage door-switching mechanism to accommodate a remote-control relay designed to operate a garage door as a result of repetitive illumination of the light-sensitive cell of the relay circuit. To carry out this object, a short duration triggering signal from the remote-control circuit may energize a solenoid circuit which operates a power switch, thereby supplying power to the door-driving motor. The switch mechanism may include a cam synchronously timed to operate a holding lever which sustains power flow from the power switch to the motor so that the door completes its cycle of travel although the solenoid is energized but for a short duration by the triggering signal.

The accompanying drawings show, for purposes of illustrating the present invention, one embodiment in which the invention may take form, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In the accompanying drawings,

Figure 1 is a schematic wiring diagram of the remote control relay circuit designed to trigger the door-operating motor circuit;

Figure 2 is a block diagram of a door-operating motor circuit operated in conjunction with the circuit of Figure 1;

Figure 3 illustrates a cam-holding mechanism to be used in conjunction with the circuit of Figure 2 and for maintaining power flow to the door-actuating motor; and

Figure 4 diagrammatically illustrates an installation of the control and garage door mechanism.

Referring now to Fig. 1, reference 10 designates a remote control relay circuit designed to couple an electrical current source 11 to a load 29. In the illustrated embodiment, source 11 is alternating current. Remote control circuit 10 includes a rectifier 12 connected to one side of an alternating current source 11. The output voltage of rectifier 12 is smoothed by a resistor 13 and a capacitor 14. Rectifier 12, resistor 13 and capacitor 14 may be eliminated if source 11 is direct current. The load circuit of rectifier 12 includes a resistor 15, a capacitor 16 and the coil of a relay 17. The circuit is completed by connecting the other side of relay 17 to a return bus 31. Bus 31 is connected to the other side of source 11. A light sensitive photocell 21 is connected in shunt electrical relationship across the series combination of capacitor 16 and the coil of relay 17. A single pole double throw switch is made up of contacts 19 and 20 cooperating with a pivoted armature 18 of relay 17. Armature 18, shown schematically, is adapted to make electrical connection alternately with contacts 19, 20. A spring 34 provides mechanical bias to maintain armature 18 in connection with contact 19 during the period the coil of relay 17 is de-energized. In a suitably mounted relay, the mechanical bias may be provided by gravity and spring 34 eliminated. Armature 18 connects to a resistor 32 in series with a capacitor 22. During the period relay 17 is non-conducting, capacitor 22 is connected to the output of rectifier 12 through resistor 32, armature 18 and contact 19.

Current flow through relay 17 causes armature 18 to establish connection with contact 20. A capacitor 23 is connected to contact 20 through a series resistance 33, and through a potentiometer 33' with the coil of relay 24. Return bus 31 is connected to capacitors 22, 23 and relay 24 to complete the circuits therefor. A single pole double throw switch is made up of contacts 26, 27 cooperating with a pivoted armature 25 of relay 24. Armature 25 is adapted to make electrical connection alternately with contacts 26, 27. A spring 35 provides mechanical bias to maintain armature 25 in connection with contact

26 during the period the coil of relay 24 is non-conducting. Current flowing through relay 24 swings armature to make connection with contact 27. Armature 25 is connected to bus 31 and, thus, to one side of source 11. A bus 30 connects the other side of source 11 to load 29. A pilot light 28 and resistance 36 are in series with bus 30 and contact 26. When relay 24 is de-energized, pilot light 36 is connected across input source 11 and will light up if source 11 is on. Current flowing in relay 24 will cause armature 25 to make connection with contact 27 and consequently throw load 29 across source 11.

Capacitor 16 is charged by the output of rectifier 12 when light-sensitive cell 21 is non-conducting. In its de-energized state, cell 21 is effectively an open circuit, and current does not flow through relay 17 because the direct current output of rectifier 12 is blocked by capacitor 16. Similarly, capacitor 22 is charged by the output of rectifier 12. It will be recalled that armature 18 is in electrical connection with contact 19 when relay 17 is de-energized.

As noted hereinbefore, remote control relay circuit 10 may be used to activate a motor operated garage door although other electrical responsive apparatus may be activated thereby too. Consequently, light sensitive cell 21 is located in the vicinity of the garage door and where it is shielded from sunlight as much as possible. Cell 21 is positioned so that it will be illuminated by the light beam of the automobile when the automobile is driven up to the garage in preparation of entry therein. Upon flickering of the automobile lights several times, cell 21 intermittently conducts current. During periods of intermittent current flow, capacitor 16 discharges and current flows around the loop consisting of cell 21, the coil of relay 17 and capacitor 16. Intermittent current flow causes armature 18 to alternate between contacts 19 and 20. During the short intervals that current flows, armature 18 is in electrical connection with contact 20, thus causing capacitor 22 to charge capacitor 23. The size of capacitor 23 is relatively large. Consequently, a number of intermittent charge intervals are required before the voltage developed across capacitor 23 is large enough to permit capacitor 23 to discharge through the coil of relay 24. Current flow through relay 24 swings armature 25 to connect with contact 27 and thus places source 11 across load 29.

Accordingly, it is seen that intermittent current flow through relay 17 causes the alternate action of condenser 22 charging condenser 23 on one hand and recharging of condenser 22 by connection with the output of rectifier 12 on the other hand.

The illumination of cell 21 by a continuous light, either sunlight or headlights of the automobile, will not produce the intermittent action hereinbefore described. When cell 21 conducts continuously there is a direct current path from rectifier 12 through resistor 15 and cell 21 to return bus 31 after the initial discharge of condenser 16; this prevents recharging of condenser 16. Consequently, the garage door will not open. This feature is put to advantage. Most people will not realize that a garage door will open only when cell 21 is illuminated by light flashes of only a particular character.

In illustrating a preferred embodiment for remote control relay circuit 10, the following values are suggested for the elements of circuit 10. A 60 milliampere rectifier 12, a 1,000 ohm resistor 13, and a 250 volt, 50 mfd. capacitor 14 are used when source 11 is 110 volt alternating current. Resistor 15 is 24,000 ohms and serves to prevent spurious discharge of capacitor 16 which may be caused by circuit irregularities. Resistor 15 has high resistance to prevent overloading of the element 21. Capacitor 16 is a 400 volt, 10 to 14 mfd. condenser, preferably an oil dielectric type or other type of condenser characteristic of very small leakage over long periods of time. Capacitor 16 is expected to remain fully charged

during long periods, for example, between morning and evening. It should, therefore, have minimum leakage.

Light-sensitive element 21 may be a cadmium sulfide photocell incorporating accommodating filter and condenser lenses as known in the art.

The resistance of the winding of primary relay 17 is in the order of 5,000 to 10,000 ohms. The resistance of resistor 32 is relatively low, in the order of 250 ohms. The resistance of resistor 33 is in the order of 1,000 ohms. Such a resistance is sufficient to require two energizations of the light cell 21. It also prevents sparking at contact 20. The potentiometer 33' may have up to 10,000 ohms and, by varying the resistance it introduces into the circuit, it is possible to tune the devices so that various pre-determined signals, such as dot-dash, dot-dot-dot, dot-dot-dot-dot, etc., may be required.

Capacitor 22 is a 250 volt, 50 mfd. condenser. Capacitor 23 is a 250 volt, 200 mfd. condenser. A relatively large resistance in the order of 2,500 to 3,000 ohms is desired in the circuit containing the winding of second relay 24. This will prevent discharge of capacitor 23 through the winding of relay 24 while the capacitor is charging up. In the illustrated embodiment, it is assumed that the winding of relay 24 has adequate resistance. Otherwise, a resistor (not shown) should be added in series with the winding of relay 24. The current limiting resistor 36 is 100,000 ohms.

For a garage door remote control motor mechanism, it is contemplated that relay circuit 10 provides a triggering signal which closes a circuit and thus causes current to flow in a solenoid. This actuates the motor and causes the garage door to open if initially closed or close if the door is initially opened. The motor actuates special switching means which keeps on the electric power until the door is completely opened. When the driver leaves the garage, he uses a manual switch which reverses the rotation of the motor to cause the garage door to close.

In illustrating the garage door mechanism, reference 29 heretofore referred to as the load is a solenoid having a movable plunger 37. When solenoid 29 is energized, movement of plunger 37 depresses an off-on button 39 of a power switch 38. Power switch 38 is designed to feed power through conductor lines 40 to a reversing switch 41. Reversing switch 41 is designed to feed power to a motor 42. Motor 42 operates the garage door, shown in Fig. 4. The combination of reversing switch 41 and motor 42 serves to reverse the rotation of motor 42 to operate the garage door in a direction to close the door when it starts from an opened position or to open the door when it starts from a closed position. The arrangement of reversing switch 41 and motor 42 is disclosed and explained in detail in copending application Serial No. 628,036, filed December 16, 1956, by Frederick A. Purdy, for Door Operators.

A main electrical source 61 may be taken from the house line. Source 61 is fed to a night lock switch 43, preferably located in the house. All the power for the door operating mechanism may be turned off by switch 43. Furthermore, source 11 may be taken from switch 43. Accordingly, switch 43 serves as a master switch for the whole system; and by turning same off, prevents operation of remote circuit 10 as well as manual operation of the garage door by a manual switch 44, as will be noted hereinafter.

A terminal board 45 receives power from switch 43 by line conductors 49. Power is taken from board 45 and sent to a manual on-off switch 44 through electrical lines 47. Manual switch 44 is preferably located in the garage near an entrance-exit door. Switch 44 feeds power to solenoid 29 through electrical lines 48. Lines 48 and the output of remote control circuit 10 are in electrical parallel relationship across the input of solenoid 29. Either circuit 10 or switch 44 is capable of energizing solenoid 29. Switch 44 permits manual operation of the garage door, and allows one to open or close the garage door upon entering the garage or upon leaving.

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ing the garage after parking the automobile therein. Electrical power is supplied to power switch 38 from terminal board 45 through line conductors 46. When solenoid 29 is energized, plunger 37 is set into motion and depresses on-off button 39 causing switch 38 to supply power to reversing switch 41 to actuate motor 42.

Remote control relay circuit 10 is suitable for energizing solenoid 29 for a short period of time. Thereafter, the de-energized solenoid 29 would normally cause plunger 37 to release button 39. This would cut off power from motor 42 prematurely, but for a cam-holding mechanism. The cam-holding mechanism maintains the supply of power without interruption for a length of time sufficient to allow motor 42 to drive the garage door from a completely closed position to a completely opened position, or vice versa. The cam-holding mechanism illustrated in the above mentioned application may be used to sustain motor operation.

Referring now to Fig. 3, the holding mechanism includes a rockable arm 50 pivoted at 51. Switch 38 is provided with a depressible button 39 urged upwardly by a spring 64 within the container of switch 38. Button 39 abuts against the under side of arm 50 to the left of 51. A stop 63 serves to support horizontally the right end of lever 50. A holding arm 52 is pivoted at 53 and biased at its upper end by a spring 54 attached to a fixed support 55. The lower end of arm 52 is adapted to rest upon arm 50 to the left of 51. In static condition, arm 50 remains substantially horizontal because spring 54 is predeterminedly selected so that it is not strong enough to pivot arm 50 in a counter-clockwise direction and depress button 39. Spring biased arm 52 will maintain arm 50 in an inclined position only if the latter is initially pivoted by another agent, such as plunger 37. Solenoid 29 is provided with movable plunger 37 and spring 59 to the right side of pivot 51. When solenoid 29 is energized, plunger 37 moves upward in the direction of arrow *a* and pivots arm 50 in the direction of arrow *b*, so that the arm 50 depresses button 39 of switch 38. This permits spring biased arm 52 to swing counter-clockwise as it follows arm 50. Lever 52 bears on arm 50 to maintain it in its inclined position after solenoid 29 is de-energized so that button 39 remains depressed for the required time interval to permit door travel from its closed position to its opened position.

Reversing switch 41 is provided with a rockable, spring-biased lever 61. The spring (not shown) maintains lever 61 normally vertical. Lever 61 will be deflected toward the left when engaged by cam 57 pivoted at 58. When lever 61 extends vertically, switch 41 is arranged for motor operation in a direction to drive the garage door open. Reverse door travel is obtained by deflection of lever 61 to the left. Cam 57 is oriented, as indicated by solid lines, when the garage door is completely closed. In this position, cam 57 does not engage lever 61. Consequently, switch 41 is set for open door travel upon subsequent operation of the system.

An oscillatory arm 62 is keyed to shaft 58. The garage door is mechanically coupled to oscillatory arm 62 in such a manner that the shaft and cam 57 will move counter-clockwise at the time the door approaches its fully opened position. In other words, cam 57 will occupy the solid line position for open door travel, but, as the door is about to become fully opened, cam 57 will turn in the direction of arrow *f* and sweep through an arc, here shown as approximately 120°, and finally occupy the position indicated by dashed lines. The cam 57 has an end 60 for operating a reversing switch 61 and another end 60' normally free of arm 52 but adapted to actuate it in a manner to be described. In the dashed line position, end 60 of cam 57 deflects lever 61. The other end 60', in the course of sweeping through its arc, will have engaged arm 52 and pivoted it about 53 in the direction of arrow *g*. This will cause holding arm 52 to pivot clockwise against bias spring 54 and release arm 50. Arm 50 will

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be urged clockwise in the direction of the arrow *i* by the upward pushing spring-pressed button 39. Consequently, arm 50 will return to its horizontal position and thus release button 39 of power switch 38, which will stop motor operation and turn the system off. By this time, the door will have occupied its fully opened position. It will be noted that, by deflection of reversing switch-operating lever 61 in the direction of arrow *h*, switch 41 has been reset to drive the door toward closed position when the system is next set into operation.

In the course of sweeping through its arc, the end 60' of cam 57 engages and rocks arm 52. When cam 57 comes to rest in its dashed line position, its end 60' no longer engages arm 52 but is spaced therefrom. Thus, arm 52 may shift slightly in the direction of arrow *d* until its lower end rests on arm 50, its upper end, as noted, being spaced from 60'. However, arm 50 remains substantially horizontal because, by predetermined selection, spring 54 is not strong enough to overcome the upward opposing force exerted by spring-pressed button 39.

As noted hereinbefore, the system may be set into operation either by manual switch 44 or intermittent illumination of cell 21. For the purpose of illustration, it is assumed that the garage door is initially closed and the system is set into operation by repeatedly illuminating cell 21. This starts a chain of events as follows. Plunger 37 moves in the direction of arrow *a* and pivots arm 50 in the direction of arrow *b*, which depresses button 39 in the direction of arrow *c* and starts motor 42. Bias spring 54 causes the lower end of arm 52 to follow by turning in the direction of arrow *d* and bear upon the left end of arm 50, whereby switch 38 is maintained in "on" position. During the open door travel, cam 57 remains stationary until the garage door is about to become fully opened, at which time cam 57 rotates counter-clockwise, as shown by the arrows *f*, and finally occupies the dashed line position. The cam end 60 will now engage and deflect lever 61 in the direction of arrow *h* to provide reverse door travel upon subsequent operation of the system. The other end 60' will have engaged arm 52 as it is swept through the arc *f* and cause arm 52 to pivot clockwise in the direction of arrow *g* and release arm 50. The released arm 50 returns in the direction of arrow *i* to substantially horizontal static position. This will release button 39 and shut off motor 42 as the door arrives at its fully opened position.

When the door is to be closed, solenoid 29 is again energized. The same operations take place so far as power switch 38 is concerned. This switch is released when cam end 60' again acts on lever 52 when traversing arc *k*.

At the time the garage door is almost fully closed, cam 57 will rotate clockwise in the direction of arrows *k* and return to its original solid line position. While sweeping through arc *k*, cam 57 will have engaged arm 52, causing it to pivot in the direction of arrow *g*, thereby releasing arm 50 and, thus, button 39. After cam 57 sweeps past arm 52, the spring biased arm 52 returns in direction *d* and rests against horizontal arm 50. During this operation, lever 61 is permitted to return to the vertical because it, too, is released by cam 57.

Although not shown, a latch may be provided at the top and at the bottom of the jamb of the garage door to engage and hold the door open or closed, as the case may be, because motor 42 does not operate for these positions. The latches may be electrically actuated and controlled by solenoid 29 so the door is released when solenoid 29 is energized to permit the door to travel to its other position.

In the diagrammatic illustration, in Figure 4, it is assumed that the light-sensitive cell 21 is mounted in a recess in the jamb of the garage door opening at about the height of the headlight beam so that it is protected against impingement of light coming from random directions and is in a position to accept light from the head-

light. The control circuit and motor-operated mechanism for shifting the door D are in the garage.

Since it is obvious that the invention may be embodied in other forms and constructions within the scope of the claims, I wish it to be understood that the particular forms shown are but a few of these forms, and, various modifications and changes being possible, I do not otherwise limit myself in any way with respect thereto.

What is claimed is:

1. A relay circuit for controlling remotely electrical responsive load apparatus comprising, a source of direct current, a relay having a relay coil and a switching armature, said switching armature being responsive to current flow through said coil by movement from a first to a second of two switching positions, a capacitor in series electrical relationship with said relay coil and being coupled to said source, signal responsive means in shunt electrical relationship across said capacitor and said relay coil, said means being electrically conductive when energized by signals, and a second capacitor coupled to said armature and being normally connected to said source and charged thereby for the first of the two switching positions, said second capacitor being alternately disconnected from and connected to said source by movement of said switching armature in response to short duration and intermittent electrical conduction of said responsive means.

2. Apparatus as defined in claim 1 further including, a third capacitor, and a second relay having a relay coil connected directly to said third capacitor, said third capacitor normally being disconnected from said second connector, said third capacitor being charged upon connection to said second capacitor by reason of movement of said switching armature to the second of its two positions during the period of disconnection of said second capacitor from said source, wherein discharge of said third capacitor through the relay coil of said second relay effects operation of load apparatus.

3. Apparatus as defined in claim 1 further including, a third capacitor, said third capacitor being charged upon connection to said second capacitor caused by movement of said switching armature to the second of its two positions during the period of disconnection of said second capacitor from said source, and said load apparatus comprising, a second relay having a relay coil and a switching armature responsive to current flow through said last-mentioned coil, said last-mentioned coil being connected directly to said third capacitor and adapted to be energized by the discharge of said third capacitor in order to actuate movement of the correlated responsive switching armature.

4. A relay circuit for controlling remotely electrical responsive load apparatus comprising, a source of direct current, a relay having a relay coil and a switching armature, said switching armature being responsive to current flow through said coil by movement from a first to a second of two switching positions, a first capacitor in electrical series relationship with said relay coil and being connected to said source, a light responsive photocell in shunt electrical relationship across said first capacitor and relay coil, a second capacitor connected to said switching armature, said switching armature normally connecting said second capacitor to said source for the first of the two switching positions and thereby causing the charge of said second capacitor, said second capacitor being alternately disconnected from and connected to said source by the switching action of said armature in response to short duration intermittent illumination of said

photocell, a third capacitor normally disconnected from said second capacitor but being connected thereto and charged thereby during disconnection of said second capacitor from said source by the switching action of said armature to the second of its positions, and load apparatus in the output circuit of said third capacitor and adapted to be energized by discharge thereof.

5. Apparatus as defined in claim 4 wherein, said load apparatus comprising, a second relay having a relay coil and a switching armature responsive to current flow through said last-mentioned coil, said last-mentioned coil being connected directly to said third capacitor and adapted to be energized by the discharge of said third capacitor in order to actuate movement of the correlated responsive switching armature, and a variable resistance coupled to said third capacitor, adjustment of said variable resistance determines the character of intermittent illumination of said photocell for the purpose of actuating said last-mentioned switching armature.

6. In actuating door operating apparatus including, a door, an electric motor, motor operating means for shifting the door from open to close position and vice versa, reverse switching means adapted to effect subsequent door movement in a reverse direction upon arrival of the door in either open or close position, and an electromagnetically operated switch for closing the motor circuit to effect door switching operation, a relay switch circuit for remotely controlling the electromagnetically operated switch comprising, a source of direct current, a light-responsive photoelectric cell in shunt electrical relationship across said source and being mounted adjacent said door and in a position to be sensitized by signals developed by the headlight beam of a vehicle, a relay having a relay coil and a switching armature, said armature being responsive to current flow through said coil by movement from a first to a second of two switching positions, a first capacitor in electrical series relationship with said relay coil and also being connected to said source, said cell being in shunt electrical relationship across said first capacitor and relay coil to form a signal responsive conducting loop, a second capacitor connected to said switching arm, said switching arm normally connecting said second capacitor to said source for the first of its two switching positions and thereby causing said second capacitor to be charged, said second capacitor being alternately disconnected from and connected to said source by switching action of said armature in response to short duration intermittent illumination signals, a second relay having a relay coil and a switching armature responsive to current flow through the last-mentioned coil by movement from a first to a second of two switching positions, a pilot light connected to said source and when said second switching armature occupies the first of its two positions, and a third capacitor normally disconnected from said second capacitor but coupled thereto and charged thereby upon disconnection of said second capacitor from said source by the switching action of said first armature to the second of its two positions, the output of said third capacitor being adapted to energize the coil of said second relay upon high intensity discharge of said third capacitor in order to switch the switching armature of said second relay to the second of its two positions, whereby said electromagnetically operated switch effects the close of the motor circuit to initiate a door shifting operation.

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