May 20, 1969 R. GOLDSTEIN 3,445,848

REMOTE CONTROL RECEIVER

Filed Oct. 13, 1965 Sheet 2 of 3

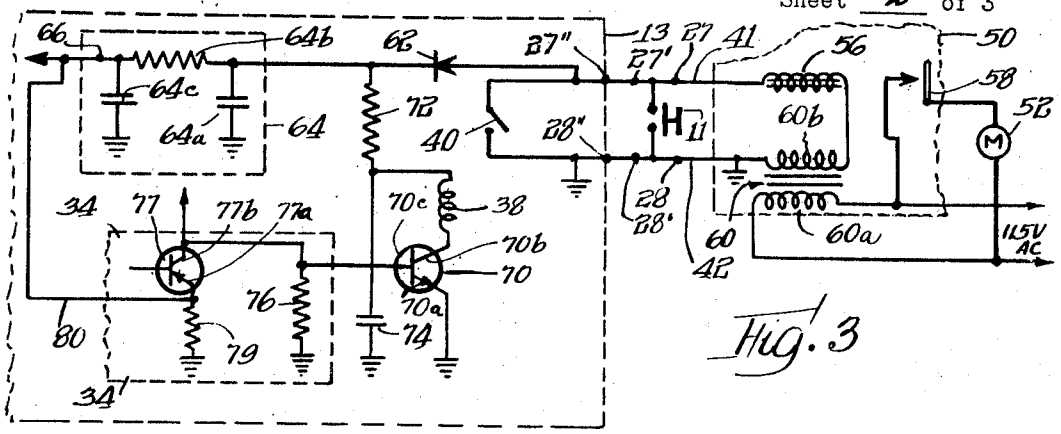

Fig. 3

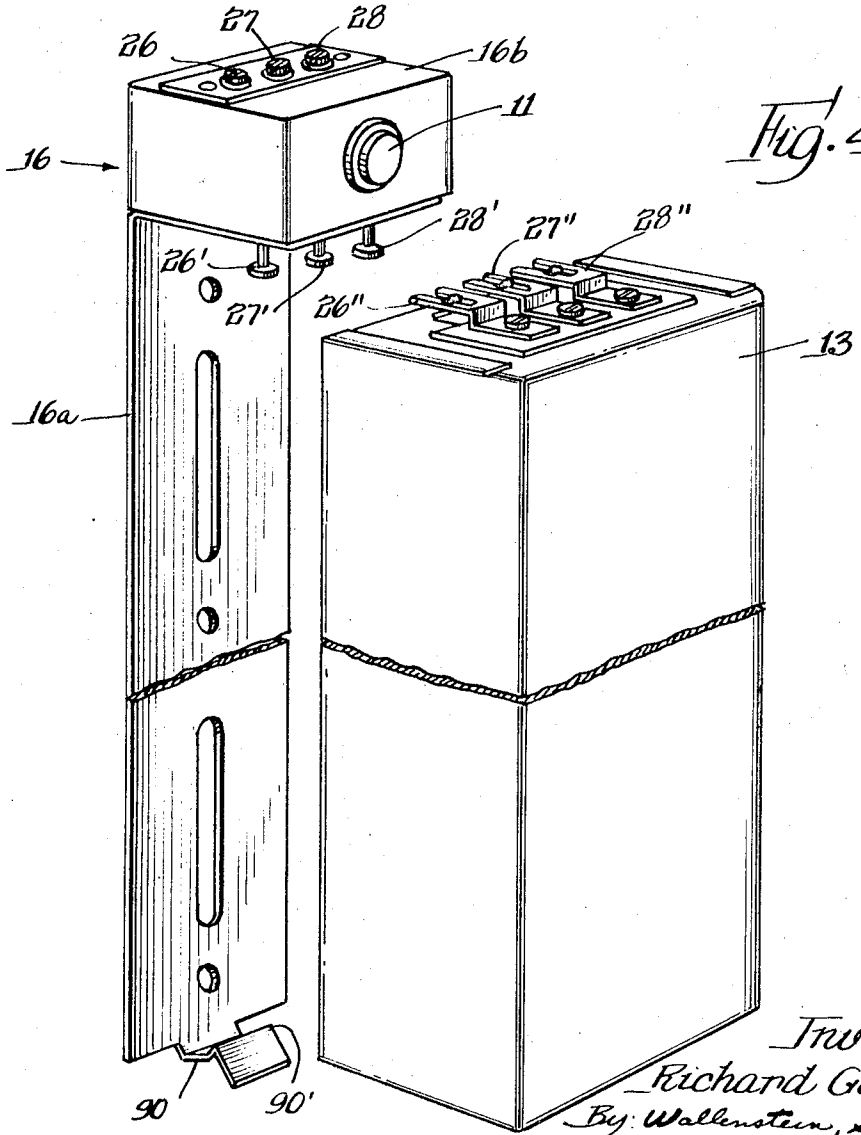

Fig. 4

Inventor
Richard Goldstein
By: Wallenstein, Spangenberg
Hattis & Strampel Attys.

May 20, 1969 R. GOLDSTEIN 3,445,848

REMOTE CONTROL RECEIVER

Filed Oct. 13, 1965 Sheet 3 of 3

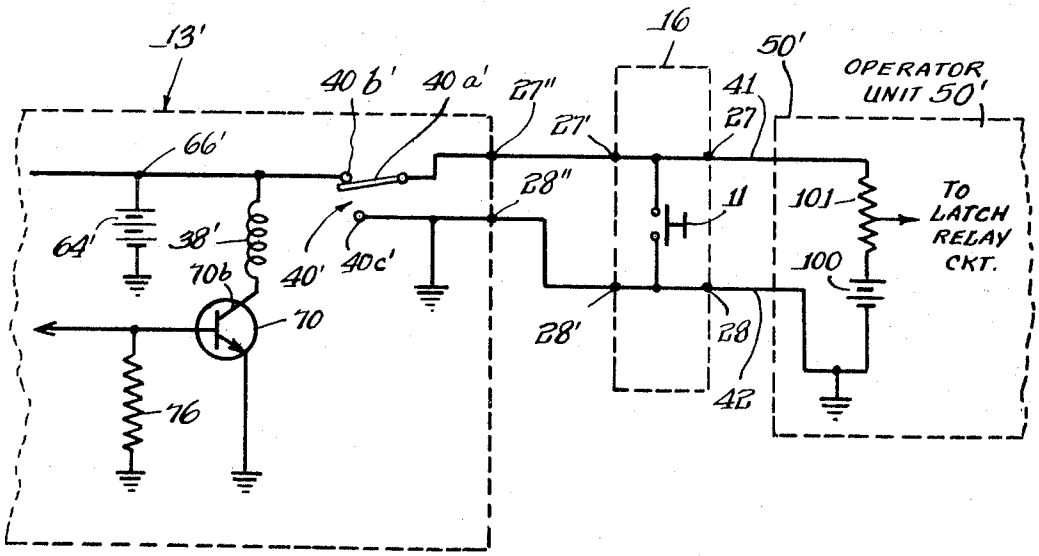

Fig. 5.

Inventor
Richard Goldstein

By Wallenstein, Spangenberg, Hattis & Strampel
attys.

United States Patent Office 3,445,848
Patented May 20, 1969

3,445,848

REMOTE CONTROL RECEIVER

Richard Goldstein, Deerfield, Ill., assignor, by mesne assignments, to Chamberlin Manufacturing Corporation, Elmhurst, Ill., a corporation of Iowa

Filed Oct. 13, 1965, Ser. No. 495,563
Int. Cl. H04b 7/00
U.S. Cl. 343—225 14 Claims

ABSTRACT OF THE DISCLOSURE

A radio control garage door operator system wherein the radio receiver obtains its energizing voltage from across the normally open contacts of the motor control relay. A chargeable current means is normally supplied by the voltage across the switch contacts and acts as a temporary supply of current to maintain the radio receiver energized when the normal energizing current is short circuited by the motor control relay upon reception of radio signals.

This invention relates to a radio control receiver useful for the remote control of electric door operators for residential garages by radio control signals received from a radio transmitter mounted in the user's cars, the signals being usually generated during the depression of a manual switch provided in the user's car.

Remote operation by radio control from the owner's automobile is the principal attraction in electric operation of residential garage doors. Nearly all electric door operators are now sold with radio remote control. Very few manufacturers of garage door operators, however, also manufacture radio control devices. Consequently the owners, dealers and installers of electric operators are often involved in separate procurement of radio control equipment which must be added as an outboard accessory item to the electric operator itself. This poses the problem of powering the radio receiver and connecting the output relay contacts of the receiver, which close each time the user operates his transmitter, into the door operator control circuit wiring. It is common practice to provide a separate integral power supply for the receiver providing for its operation directly from the common 115 volt AC supply, and a pair of wires or binding post terminals to make connections from the relay contacts into a 24 volt AC low voltage control circuit which includes a doorbell type manual control push button on the garage wall for manually controlling the door operator. Some manufacturers use multi-connector plugs and sockets between the operator housing and radio receiver to provide a single means of supplying power to the receiver and connecting to its relay contacts. However no industry standards exist and a great variety of plugs and methods of connection are found in the field.

An object of the invention is to provide a radio receiver which is quickly adaptable to nearly all makes of operators and whose method of connection is the same in all cases.

Another object of the invention is to provide a radio receiver as described which requires no external source of power for its operation so that separate connections do not have to be made to a 115 volt supply.

A further object of the invention is to provide a radio receiver as described which can readily be added to most electric garage door operators not originally provided with a radio control feature by the simple expedient of electrically connecting the above mentioned relay contacts across the terminals of the aforesaid manual control push button. A related object of the invention is to provide a radio receiver as described wherein the radio receiver can be physically disconnected by unskilled persons quickly and easily from the operator portion of the system so that any user can take a defective radio receiver to a repair location and thus minimize service time and repair costs.

The receiver of the invention most preferably uses extremely low power for stand-by operation where its signal receiving and signal processing circuits are energized and ready to operate the relay circuit upon receiving a properly coded signal. Transistorized circuits, for example, satisfy such low power requirements. In a manner to be explained, the receiver is designed to operate with most of the modern garage door operators which employ a low voltage motor control circuit including a transformer for reducing the 115 volt supply voltage to approximately 24 volts so that the external control circuit wiring complies with the National Electrical Code requirements for limited energy wiring. Such circuits are typical of those used for wiring door bells and chimes in residences and are easily installed with open type wiring involving no shock hazard to the user. The wall mounted door bell type push button switch (usually installed in the garage at a convenient location for the home owner to open or close his garage door when leaving or entering the garage) is a normally open switch connected in series with the 24 volt winding of the transformer described above to actuate a relay that switches the garage door operating motor on and off. Because of the safety feature obtained if the door can be stopped by a second impulse from the wall push button switch, virtually all residential garage door operators employ a "sequence" type relay for controlling the motor. These relays are characterized by having two static or steady states, namely "on" and "off." They are switched from one state to the other very rapidly by a short application of their rated coil voltage; 1/10 of a second is a typically adequate time for actuation.

In accordance with one aspect of the invention, the power input terminals of the receiver (as well as the receiver relay contacts) are connected in parallel with the terminals of the aforesaid normally open push button switch so that the receiver derives its power for stand-by operation from the 24 volt transformer through the coil of the sequence relay in the operator described or from a similar direct current (DC) voltage where the operator uses a DC sequence relay circuit. In such case, in order for the receiver to actuate the sequence relay in the operator, the receiver must be capable of operating during the momentary short-circuiting of its own source of power.

With an operator including a sequencing relay as described, it is important that the output relay contacts of the receiver (which are connected in parallel with the manual push button switch) close only once for a duration necessary to actuate the operator each time the manual push button of the transmitter in the user's car is operated to initiate a garage door opening or closing operation. If the output relay contacts chatter or close more than once in such case, the second contact closure could stop or reverse the motor and cancel out the operation called for. In the case where the closure of the output relay contact short-circuits the source of power for the relay and the receiver, a problem exists if the output relay loses its power so quickly that the operator is not actuated or, more likely, if the output relay contacts chatter or open and close several times during the transmission of a radio control signal as the output relay de-energizes and then becomes re-energized as its relay contacts repeatedly reopen to reestablish the feeding of power to the receiver, with the undesirable result referred to above.

Therefore in accordance with another aspect of the invention, the receiver is provided with a chargeable electrical energy storage circuit, preferably a capacitor-resistance network or a rechargeable battery, which maintains the receiver circuits energized during the short-circuiting of the power input circuit. Where a capacitor-resistance network is utilized which includes a capacitor element which can discharge during the reception of a radio control signal to a point which results in a reopening of the output relay contacts before the cessation of the radio control signal, the receiver is designed to prevent multiple closure of the output relay contacts during the reception of a cintinuous radio control signal. A relay contact opening and subsequent closure inhibiting circuit is provided for this purpose which circuit becomes effective upon initial closure of the relay contacts following the reception of each radio control signal. Since the power input and relay output terminals of the receiver are the same two terminals, the receiver can be easily installed in conjunction with most garage door operators by the simple expedient of electrically connecting the receiver terminals across the terminals of the manual push button switch in the garage.

A still further advantage in installation and servicing of the receiver is achieved if the garage manual push button switch and the receiver are physically related. Thus, the manual push button switch is preferably mounted on a wall mounted frame which includes exposed contact terminals extending to the switch. The frame is arranged removably to receive the radio receiver which has exposed terminals which automatically make contact with the aforesaid contact terminals of the frame when slid into place on the frame. If any servicing problems arise, the user merely slides the radio receiver from the mounting frame and takes the same to a receiver servicing shop, thereby saving time and expense for all concerned.

The above and other advantages and features of the invention will become apparent upon making reference to the specification to follow, the claims and the drawings wherein:

FIG. 1 shows the inside of a garage provided with the various components which make up an electronic garage door operator system, the radio receiver portion thereof being constructed in accordance with the present invention;

FIG. 2 is a basic block diagram of the various electrical components utilized in the electronic garage door operator system of FIG 1;

FIG. 3 is a detailed schematic diagram including the output portion of the radio receiver portion of FIG. 2 and illustrating the preferred receiver circuit of the present invention;

FIG. 4 shows an exploded view of the radio-receiver unit of the invention and the mounting frame therefor; and

FIG. 5 is a circuit diagram of a modified receiver circuit of the present invention utilized with an operator which supplies a source of direct current to the receiver circuit.

FIG. 1 shows an electronic garage door operator system installed in a garage having a garage door which rides on side tracks **3**, only one of which in shown in FIG. 1. The means for opening and closing the garage door includes a carriage arm **4** which connects to the garage door near the top thereof. The carriage arm **4** illustrated in the drawing is mounted for reciprocating movement along a rail **5** secured to the ceiling of the garage. The rail carries suitable mechanism which moves the carriage arm in one direction or the other depending on the direction of rotation of the shaft of an electric motor mounted within a housing **7** attached to the ceiling of the garage. (It is apparent that any one of a number of other well known mechanical arrangements may be provided for coupling the motion of the motor to the garage door.)

The housing **7** includes, in addition to the motor, various other equipment such as an operator unit (not shown in FIG. 1) which controls the operation of the motor, and an electric lamp **9** extending from the housing **7**. The electric motor may be of a type where the motor reverses in direction each time it is re-energized. In such case, the motor reverses automatically by a special arrangement of a centrifugal switch which sets up a starting winding thereof in opposite polarity with respect to a running winding thereof each time the motor comes to rest. The lamp **9** is automatically turned on when the garage door starts in motion and remains lighted several minutes after the movement of the door stops.

The garage door operator unit is actuated from the vicinity of the garage by a manual push button switch **11** shown mounted on the wall of the garage. A pair of wires extends from the switch **11** to the door operator unit within the housing **7**. When the user desires to open the garage door, he presses the manual push button switch **11**, whereupon the motor becomes energized and effects movement of the carriage arm **4** to the right along the rail **5**. When the door reaches the end of its path of travel, a limit switch (not shown) shuts off the motor. When the manual switch **11** is depressed again, the motor becomes energized again and returns the carriage arm **4** to the position shown in FIG. 1 where the door is in a closed position. A limit switch (not shown) is provided for automatically terminating the operation of the motor when the door is closed. The motor will continue to reverse its direction of rotation each time the manual switch **11** is depressed.

As previously indicated, it is common to incorporate remote radio control from the user's car, in addition to the manual control as described, over the operation of a garage door. To this end, a transmitter (not shown in FIG. 1) is installed in the user's automobile. The transmitter usually includes a push button control which when depressed will cause the transmitter to generate an amplitude modulated signal. The modulation frequency of the radio signal is varied within a given location encompassing the range of the transmitter involved, so that the signal from a given transmitter will only operate the desired garage door. The radio signal is received by a receiver unit which is generally incorporated within the housing **7**. In such case, when trouble develops in the receiver, the inaccessibility thereof usually required a service man to disconnect the receiver and bring the same to a radio servicing shop.

As previously indicated, the present invention relates to an improvement in the circuitry and the manner of mounting the receiver which greatly simplifies the installation and servicing thereof. The receiver is an integral unit identified by reference numeral **13** and is removably mounted on a mounting frame **16** including the manual push button switch **11**. The connections between the receiver unit and the mounting frame are simple removable type plug-in or similar connections. When the receiver unit **13** is mounted in place on the frame **16**, the receiver unit is automatically connected to the operator unit and to a source of power for the receiver unit. If the receiver unit needs servicing, the user merely pulls the exposed receiver unit **13** from the frame **16** and takes the same to a service shop, thereby saving much time and expense for all concerned.

The electrical connection of the receiver unit to a source of power and to the operator unit within the housing **7** is greatly simplified by the fact that the sole electrical connection required between the receiver unit **13** and the rest of the system is the connection of two terminals on the receiver unit in parallel with the terminals of the manual push button switch **11**. The receiver unit **13** thus receives its stand-by power from across the terminals of the manual push button switch **11**. When the radio receiver unit **13** receives a radio control signal calling for a door opening or door closing operation, the out-

put stages of the receiver unit **13** effect short-circuiting of the terminals of the push button switch **11**, which disconnects the source of power for energizing the receiver unit **13**. (If the receiver unit operates a relay, the short circuit would be effected by closure of relay contacts, but the invention is applicable to use of a solid state switch instead of a relay.) In the absence of special circuitry like that to be described, the loss of power to the receiver unit would result in the almost immediate removal of the short circuit across the terminals of the manual push button switch. Such a momentary short circuit may not actuate the operator unit. Even if the operator unit were to operate under these conditions, if the radio control signal persists, the reestablishment of power to the receiver unit upon removal of the short circuit would again reestablish the short circuit condition. In effect, therefore, the operator unit would be intermittently pulsed, which would cause the motor alternately to stop and reverse, thereby failing to carry out the desired garage door opening or door closing function.

Refer to FIG. 2 which shows a basic block diagram of the electrical components of a preferred garage door control system. The radio transmitter installed in the user's automobile is therein identified by reference numeral **18**. The transmitter **18** has a manually operable push button switch **20** which is depressed by the user to energize the transmitter which then generates an amplitude modulated signal on an antenna **22**. The transmitted signal is received by a receiving antenna **24** which may comprise a length of wire secured to a terminal **26** (FIG. 3) on the top of the mounting frame **16**. The mounting frame **16** also preferably has exposed upper terminals **27** and **28** and exposed bottom terminals **26'**, **27'** and **28'** which engage with correspondingly located exposed terminals **26''**, **27''** and **28''** on the receiver unit **13**. The terminals of the manual push button switch **11** are connected respectively on the mounting frame terminal pairs **27–27'** and **28–28'**.

For the most part, the receiver unit **13** has the usual circuitry for receivers of this type. Thus, various amplifier and detector stages **30** are provided to amplify the receiver signal and detect the same to provide a signal representing the amplitude modulation of the transmitted signal. A signal decoding circuit **32** is coupled to the output of the amplifier and detector stages **30**, the decoding circuit **32** responding only to the modulation frequency assigned to the particular garage door operator system involved. One or more direct current amplifier stages is coupled to the output of the decoding circuit **32** and the output of the direct current amplifier stages is coupled to an output switching circuit indicated by reference numeral **36**, which will effect short-circuiting of the terminals of the manually operable switch **11** when the receiver receives the proper radio control signal.

In the exemplary form of the invention being described, the output switching circuit is a relay driver circuit which, in response to a control signal at the input thereof, energizes a relay **38** to close a pair of contacts **40**. The relay contacts **40** are respectively connected to the exposed terminals **27''** and **28''** on the receiver unit **13** which, as above identified, connect with the terminals of the push button switch **11**, through the mounting frame terminals **27'** and **28'**. The mounting frames **27** and **28** connected to the terminals of the push button switch **11** are connected by conductors **41** and **42** to the input terminals **45** and **46** of the operator unit identified in FIG. 2 by reference numeral **50** which includes the circuitry which controls the energization and de-energization of the motor **52**.

The operator unit **50** can be energized from a suitable source **54** of energizing voltage which may be a source of direct current or alternate current. The alternating current source would generally be the low voltage secondary winding of a transformer fed from the 60 cycle per second commercial 115 volt power lines. If the operator unit **50** has circuitry operating on direct current, the operator unit would include suitable rectifier circuits for rectifying and filtering the alternating current involved.

When the manual push button switch **11** is closed, the source of energizing voltage within the operator unit **50** is coupled to relay or other control element within the operator unit **50**, which controls the motor **52**. When the manual push button switch is open, the latter voltage appears across the terminals of the switch and this voltage is utilized as a source of stand-by power for the receiver unit **13**. By means of the preferred exemplary circuitry now to be described, this voltage is used to power the various stages of the receiver unit requiring stand-by power, such as the stages **30**, **34**, and **36**, and, when the receiver relay contacts **40** are closed and the source of power to the receiver unit is thereby short-circuited, this circuitry prevents chattering of the relay contacts **40**.

Refer now to FIG. 3 which shows the preferred receiver circuitry of the present invention, and a portion of the circuitry of the operator unit **50** typically found in operator units available today. The operator unit illustrated in FIG. 3 may include a sequencing or latching type relay **56** which, in response to a pulse of a given minimum duration, latches in one position to close the associated contacts **58**, and, in response to the next received similar pulse of current, unlatches itself to open the contacts **58**. The contacts **58** are shown controlling the feeding of a source of 115 volt AC to the terminals of the motor **52**. The latching relay **56** illustrated in the drawings is a 24 volt relay and so a transformer **10** is provided having a primary winding **60*a*** which is connected across the source of alternating current and a secondary winding **60*b*** which reduces the voltage to **24** volts. The terminals of the manual push button switch **11** are connected in series with the secondary winding **60*b*** of the transformer **60** and the latching relay **56**, so that momentary closure of the switch **11** will couple 24 volts AC to the relay **58** to latch or unlatch the same. When the manual push button switch **11** is open, the full 24 volts of the transformer secondary winding appears across the terminals of the manual push button switch **11**.

The present invention is also useful with an operator circuit where direct current is used to power the relays or other current control elements involved. In such case, the closure of the manual push button switch **11** would couple a direct current voltage to one of the control elements involved, and, when the switch **11** is opened, the direct current voltage involved will appear across the terminals of the switch. Such a circuit will be described later on in the specification.

In the circuit of FIG. 3, the bottom terminal of the manual push button switch **11** is connected to the mounting frame terminal **28** which is grounded. The other terminal of the push button switch is connected through the mounting frame terminal **27'** and the receiver unit terminal **27''** to a rectifier **62** arranged to pass a positive going voltage to an input of a filter circuit **64**. The filter circuit **64** comprises a capacitor **64*a*** connected between the input of the filter and ground, a resistor **64*a*** and a capacitor **64*c*** connected between the end of the resistor **64*b*** remote from the capacitor **64*a*** and ground. Thus, where AC voltage appears across the open manual push button switch **11**, the rectifier **62** will rectify the same by passing only the positive pulsations and the filter circuit smoothes the amplitude variations and presents a constant DC voltage at its output terminal **66**. The output terminal **66** is connected to the various stages of the receiver requiring a direct current energizing voltage. When the relay contacts **40** close to short-circuit the manual push button switch **11**, the rectifier **62** will prevent the discharge of the capacitors **64*a*** and **64*c*** through the short circuit, thereby helping in preserving the charge on the capacitors **64*a*** and **64*c***. As will appear, the contacts **40** close for such a short period that no significant discharging of the capacitors **64*a*** and **64*c*** takes place.

As illustrated, the relay driver circuit **36** includes an NPN transistor having a grounded emitter electrode **70***a* and a collector electrode **70***b* connected through the coil of relay **78** to a resistor **72** in turn connected to the cathode side of the rectifier **62**. For reasons to be explained, resistance of resistor **72** is much greater than the resistance of the relay coil (e.g. 10,000 ohms verses 1000 ohms). A capacitor **74** is connected between the juncture of resistor **72** and the coil of the relay **38** and ground so that the capacitor **74** is in parallel with the load circuit and the emitter and collector electrodes of the transistor **70** and in series with the resistor **72**. Under these circumstances, the capacitor **74** will charge to a voltage near the average value of the half cycle of the alternating current waveform passing through the rectifier **62**.

As illustrated, the amplifier stage **77** is provided including a PNP transistor **77** whose emitter electrode **77***a* is connected through a resistor **79** to ground and whose collector electrode **77***b* is connected to the end of the resistor **76** connected to the base electrode **70***c* of the transistor **70**. The emitter electrode **77***a* of the transistor **77** is connected by a conductor **80** to the positive output terminal **66** of the filter circuit **64**.

When the receiver unit **13** is not receiving a radio control signal assigned to it, the transistor **70** will be in a relatively non-conductive state which will effectively put ground potential on the base electrode **70***c* of the relay driver transistor **70** which keeps the latter transistor non-conductive.

When the receiver unit **13** receives a radio control signal having the modulation frequency assigned to it, the detected control signal renders the direct current amplifier transistor **77** conductive which will couple the positive voltage on the conductor **80** to the base electrode **70***c* of the relay driver transistor **70** to render the same highly conductive. This will energize the relay **38** causing closure of its relay contacts **40** to short-circuit the source of power to the radio receiver unit. The time constant of the circuits to which the filter circuit **64** is connected, namely the load circuits of the various stages **30**, **34** and **36** of the receiver is sufficiently great that the filter circuit capacitor **64** will not discharge very much for the period the relay contacts **40** remain closed, and so the control signal will remain on the base electrode **70***c* of the relay driver transistor **70** depsite the momentary closure of the relay contacts **40**.

The amount of current which will initially flow through the relay driver transistor **70** when it begins conducting is dependent upon the voltage to which the capacitor **74** was charged, and this current is made of sufficient magnitude to energize the relay **38**. However, the conduction of the transistor **70** will put an impedance across the capacitor **74** which is small (e.g. 1000 ohms) relative to the resistance of the series resistor **72** (e.g. 10,000 ohms) and so the capacitor **74** discharges through the load circuit of the transistor **70**, the discharge period being such that a high relay energizing current will last for a sufficient time to keep the contacts closed to operate the operator unit **50**. If the capacitor **74** has a value of 200 microfarads, the discharge time constant will be about 0.2 second, a sufficient time to actuate the operator. When the capacitor **74** is discharged, the current flowing through the relay coil is dependent primarily on the value of resistor **72** which is so great that the current then flowing in the transistor **70** and relay coil is insufficient to energize the relay. Accordingly, the relay contacts **40** will open to reestablish the connection of the source of power to the filter circuit **64** of the rectifier **62**. The current flowing in the transistor **70** continues to be insufficient to energize the relay **38** until the control signal on the base electrode disappears (which renders the transistor **70** non-conducting again to enable the capacitor **74** to recharge to the value of the voltage applied to the filter circuit) and reappears again.

Refer now to FIG. 4 which illustrates an exploded view of the receiver unit **13** and the mounting frame **16** including the manual push button switch **11**. As there shown, the mounting frame **16** has a mounting portion **16***a* which is anchored to the wall by screws or the like. The upper end of the mounting portion **16***a* terminates in a forwardly projecting head portion **16***b* having three exposed screw terminals **26**, **27** and **28** on the top thereof constituting the previously mentioned similarly numbered terminals **26**, **27** and **28**, respectively connected to the antenna wire **24** and the conductors **41** and **42** extending to the operator unit **50**. The bottom of the head portion **16***b* of the mounting frame **16** has headed studs **26'**, **27'** and **28'** constituting the previously mentioned similarly numbered terminals **26'**, **27'** and **28'**. The receiver unit **13** has three raised bificurated terminal strips **26''**, **27''**. and **28''**, constituting the aforesaid similarly numbered receiver terminals **26''**, **27''** and **28''**. These bificurated terminals strips are respectively designed to make physical and electrical engagement with the headed studs **26'**, **27'** and **28'** projecting from the bottom of the head portion **16***b* of the mounting frame **16** when the receiver unit **13** is moved against the mounting portion **16***a* of the frame **16**.

The receiver unit **13** is held in place on the mounting frame by a means of a spring detent arm **90** projecting forwardly from the bottom end of the mounting portion **16***a* of the mounting frame **16**. The spring detent arm **90** snaps into place beneath the receiver unit when the latter is slid into position where the bificurated terminal strips **26''**, **27''** and **28''** make engagement with the headed studs **26'**, **27'** and **28'**. A recess (not shown) may be provided in the bottom wall of the receiver unit **13** to receive a projection **90'** of the spring detent arm **90**.

Refer now to FIG. 5 which illustrates portions of a receiver unit **13'** which is a modification of the preferred receiver unit shown in FIG. 3. The receiver unit **13'** is utilized with an operator unit **50'** which includes a DC latch relay circuit (not shown) which is operated to its opposite states by successive closure of the manual push button switch **11**. A source of DC voltage **100** is provided in the illustrated operator unit **50'** which has a grounded negative terminal connected by conductor **42** to mounting frame terminal **28** and a positive terminal connected through a resistor **101** and conductor **41** to mounting frame terminal **27**. The push button switch **11** is connected within the mounting frame **16** across the mounting frame terminals **27–27'** and **28–28'** which, in turn, are respectively connected to receiver terminals **27''** and **28''** of the modified receiver unit **13'**. When the push button switch **11** is open and the terminals thereof are not externally short circuited, the voltage of the DC voltage source **11** appears across the receiver terminals **27''–28''**.

The receiver unit **13'** differs from the receiver unit **13** shown in FIG. 3, among other things, in that the filter circuit **64** is replaced by a low capacity rechargeable battery **64'** normally connected across the receiver terminals **27''–28''** (through chassis ground) so that the battery is normally retained in a fully charged state. A normally closed section of a single-pole, double- throw set of contacts **40'** of a relay **38'** controlled by the relay driver transistor **70** are connected between the ungrounded receiver terminal **27''** and the positive terminal **66'** of the battery **64'**. (If desired, the rectifier **62** of FIG. 3 could replace the normally closed section of the contacts **40'**, but in a DC input circuit the contact arrangement may be less costly.) The contacts **40'** include a movable contact or pole **40***a'* connected to the receiver terminal **27''** which contact **40***a'* normally makes contact with a stationary contact **40***b'* extending to the positive terminal **66'** of the battery **64'** which connects to the various stages of the receiver circuit, as in the case of the terminal **66** of the filter circuit **64** in FIG. 3. The contacts **40'** further include a stationary contact **40***c'* which is contacted by the movable contact **40***a'* when

the relay **38'** is energized. The coil of the relay **38'** is connected between the collector electrode **70***b* of the transistor **70** and the positive terminal **66'** of the battery **64'**. (It should be noted that the circuit of transistor in FIG. 5 omits the resistor **72** and capacitor **74** used in the receiver circuit of FIG. 3.)

When the receiver unit **13'** is on stand-by operation, the circuits of the receiver unit receive their energizing current from the DC voltage source **100** in the operator unit. As above indicated, the low capacity rechargeable battery **64'** is maintained in a full state of charge by the DC voltage source **100**.

When the receiver unit receives a radio control signal, the transistor **70** will be rendered highly conductive as explained in connection with the transistor **70** in the circuit of FIG. 3, whereupon the relay **38'** will become energized, causing the movable contact **40***a'* to move from the stationary contact **40***b'* to the grounded stationary contact **40***c'* and the consequent shorting of the terminals of the manual push button voltage **11** and actuation of the operator unit as previously explained. Also, the low capacity battery **64'** will be disconnected from the short circuit, and will then supply the current necessary to maintain the receiver stages including transistor **70** energized for the expected duration of the control signal. The rechargeable battery **64'** is designed to have a capacity which would maintain proper energization of the receiver for a number of successive radio control signals.

It is apparent that the present invention provides an exceedingly easy to install and service receiver unit. Also, the receiver unit can be installed with practically any garage door motor operator units having an alternating current or direct current circuit to be switched by a normally open manual push button switch.

I claim:

1. In a garage door control system including garage door driving motor means; an operator circuit for the motor means; a momentarily manually operable normally open switch for actuating said operator circuit from the garage area; a source of voltage connected by said manually operable switch to said operator circuit whereby the momentary closure of the manual switch couples an energizing voltage to said operator circuit and wherein the voltage of the source of voltage appears across said manual switch when the switch is open and is not externally short circuited, the initial closure of the switch effecting movement of the garage door in one direction by the motor means and the next closure of the switch stopping the garage door or effecting a reversal in the direction of movement thereof by the motor means; and a radio transmitter in the user's car for generating a radio control signal for remotely operating said operator circuit; the improvement comprising: a radio receiver for receiving said radio control signal and for effecting the feeding of energizing voltage to said operator circuit once for each sustained radio control signal received thereby, said receiver including an output switching circuit connected in parallel with said manual switch. the output switching circuit including means responsive to the receipt of an operating signal for momentarily shorting the terminals of the manual switch when the receiver receives a control signal, the receiver having stages for receiving and amplifying the radio control signal received by the radio receiver and applying a corresponding operating signal to the output switching circuit provided the receiver stages have sufficient energizing current supplied thereto, said receiver stages being coupled across said manual switch to be energized from the voltage thereacross as long as the terminals of said manual switch remain open, and chargeable current supplying means coupled to said source of voltage normally to be charged thereby and coupled to said radio receiver stages for supplying energizing current thereto for the duration of each radio control when the terminals of said manual switch are short-circuited by said output switching circuit.

2. The garage door control system of claim **1** wherein there is provided means for preventing the discharge of said chargeable current supplying means through said short circuit across the manual switch when a radio control signal is received by the receiver.

3. The garage door control system of claim **2** wherein said source of voltage is a source of alternating current voltage and said means for preventing discharge of said chargeable current supplying means is a rectifier device connected between said manual switch and said chargeable current supplying means.

4. The garage door control system of claim **2** wherein said means for preventing discharge of said chargeable current supplying means includes switch means between the manual switch and chargeable current supplying means, and there is provided means for controlling said switch means for effecting opening of the switch means when the receiver receives a radio control signal and effecting closure thereof at other times.

5. The garage door control means of claim **1** wherein said chargeable current supplying means is a rechargeable battery.

6. The garage door control system of claim **1** wherein there is provided a mounting frame for mounting the receiver, the mounting frame carrying said manual switch, a pair of terminals on said frame connected to the terminals of said manual switch, said frame including means for releasably holding the receiver unit in place thereon, and said receiver having an outer housing with terminals coupled to said chargeable current supplying means, receiver stages and said output switching circuit, and the latter terminals automatically engaging said mounting frame terminals when the receiver is mounted on the frame.

7. In a garage door control system including garage door driving motor means; an operator circuit for the motor means; a momentarily manually operable normally open switch for actuating said operator circuit from the garage area; a source of voltage connected by said manually operable switch to said operator circuit whereby the momentary closure of the manual switch couples an energizing voltage to said operator circuit, the initial closure of the switch effecting movement of the garage door in one direction by the motor means and the next closure of the switch stopping the garage door or effecting reversal in the direction of movement thereof by the motor means; and a radio transmitter in the user's car for generating a radio control signal for remotely operating said circuit; the improvement comprising: a radio receiver for receiving said radio control signal and for effecting the feeding of energizing voltage to said operator circuit only once for each sustained radio control signal received thereby, said receiver including an output switching circuit connected in parallel with said manual switch, the output switching circuit including means responsive to the receipt of an operating signal for momentarily shorting the terminals of the manual switch when the receiver receives a control signal and for preventing the re-occurrence of the short-circuit until said radio control signal disappears and again re-occurs, the receiver having stages for receiving and amplifying the radio control signal received by the radio receiver and applying a corresponding operating signal to the output switching circuit provided the latter stages have sufficient energizing voltage applied thereto, circuit means for applying energizing voltage to said receiver stages comprising a capacitor-containing circuit coupled across said manual switch and said receiver stages for coupling the open circuit voltage of said manual switch to said receiver stages as long as the terminals of said manual switch remain open, the capacitor of said capacitor-containing then charging to a given voltage level capable of sustaining the energization of said receiver stages when

the terminals of said manual switch are momentarily short-circuited.

8. The garage door control system of claim 7 wherein there is provided unidirectional conduction means between said capacitor-containing circuit and the portion of said output switching circuit which short-circuits the manual switch, which unidirectional conduction means permits charging of the capacitor from the open-circuit voltage across said manual switch and prevents discharging of the capacitor through the short-circuit.

9. The garage door control system of claim 7 wherein there is provided a mounting frame for mounting the receiver, the mounting frame carrying said manual switch, a pair of terminals on said frame extending to the terminals of said manual switch, said frame including means for releasably holding the receiver unit in place thereon, and said receiver having an outer housing with terminals connected to said capacitor-containing circuit and said output switching circuit, and the latter terminals automatically engaging said mounting frame terminals when the receiver is mounted on the frame.

10. The garage door control system of claim 7 wherein said capacitor discharges through the output switching circuit after short-circuiting of the manual switch, the discharging of the capacitor terminating the flow of energizing current through the output switching circuit, and means for preventing the recharging of the latter capacitor to a level which operates the output switching circuit following the termination of the short-circuiting of said manual switch.

11. A radio receiver for a garage door control system including a motor operator circuit for operating the garage door, a source of control voltage for the operator circuit, and a momentarily manually operable normally open switch at the garage connected in series between said source of control voltage and said operator circuit for operating the same when momentarily closed, the voltage from said source of control voltage appearing across said manual switch when the same is open and not short circuited, said receiver adapted to receive a radio control signal for remotely operating said garage door operator circuit, said receiver including: terminal means to be connected across said manual switch, a current control device having load terminals coupled to said terminal means, and a control terminal which, when a control signal is applied thereto, causes a relatively high level of current to flow through the load terminals when voltage is applied to the load terminals, through said terminal means, an output switching device controlled by said current control device which output switching device is connected across the normally open terminals of said manual switch to short-circuit the same when a relatively high current is flowing through the load terminals of the current control device to operate said operator circuit, said receiver further having stages for receiving and amplifying radio control signals received by the receiver and applying a corresponding control signal to the control terminal of said current control device provided the stages have sufficient energizing voltage applied thereto; a chargeable voltage supplying means coupled to the terminals of said manual switch, the chargeable voltage supplying means being charged by said source of voltage to which the manual switch is connected so long as the manual switch is not closed or short-circuited, the chargeable voltage supplying means being coupled to said receiver stages to keep the same energized for a while after the manual switch is short-circuited, to maintain a control signal on the control terminal of said current control device for at least a sufficient period of time to effect operation of said operator circuit.

12. The radio receiver of claim 11 wherein said chargeable voltage supplying means is a rechargeable battery coupled across said manual switch.

13. The radio receiver of claim 11 wherein said chargeable voltage supplying means includes a capacitor circuit coupled across said manual switch, and there is provided a capacitor coupled in parallel with the load terminals of said current control device and a resistor coupled in series between the latter capacitor and said load terminals and the terminals of the manual switch, the resistor permitting the charging of the latter capacitor to a level initiating and momentarily supporting the high current level of the current control device when said signal is applied to the control terminal of the current control device until the capacitor discharges below a given level, and said resistor being of such a high value that said capacitor cannot recharge to said level again until the current control device becomes non-conductive upon the disappearance of the control signal on the control terminal of the current control device.

14. The radio receiver of claim 11 combined with a mounting frame for mounting the receiver, the mounting frame carrying said manual switch, a pair of terminals on said frame extending to the terminals of said manual switch, said frame including means for releasably holding the receiver unit in place thereon, and said receiver having an outer housing with terminals connected to said chargeable voltage supplying means and said output switching device, and the latter terminals engaging said mounting frame terminals when the receiver is mounted on the frame.

References Cited

UNITED STATES PATENTS

2,558,434	6/1951	Hofberg	325—37
3,170,141	2/1965	Nestlerode	340—171
3,277,307	10/1966	Smeton et al.	317—147

JOHN W. CALDWELL, *Primary Examiner.*

A. J. KASPER, *Assistant Examiner.*

U.S. Cl. X.R.

49—25; 317—147; 325—393, 492; 340—171