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 33014
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[54] **REMOTE CONTROL DEVICE**
 3 Claims, 2 Drawing Figs.

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 317/148.5, 340/148
 [51] Int. Cl. **H01h 47/20**
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 340/148, 261; 325/325; 307/117; 318/16

[56] **References Cited**
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ABSTRACT: This application is directed to a remotely actuated switch which utilizes an actuatable and deactuatable ultrasonic transmitter, and an ultrasonic receiver remote from the transmitter. The ultrasonic receiver has an ultrasonic detector, amplifier, rectifier, and a bistable flip-flop for controlling a relay. The bistable flip-flop is itself controlled by a pulse generator employing a neon tube. The pulse generator also is responsive to the output of the rectifier and provides a spurious signal rejection function.

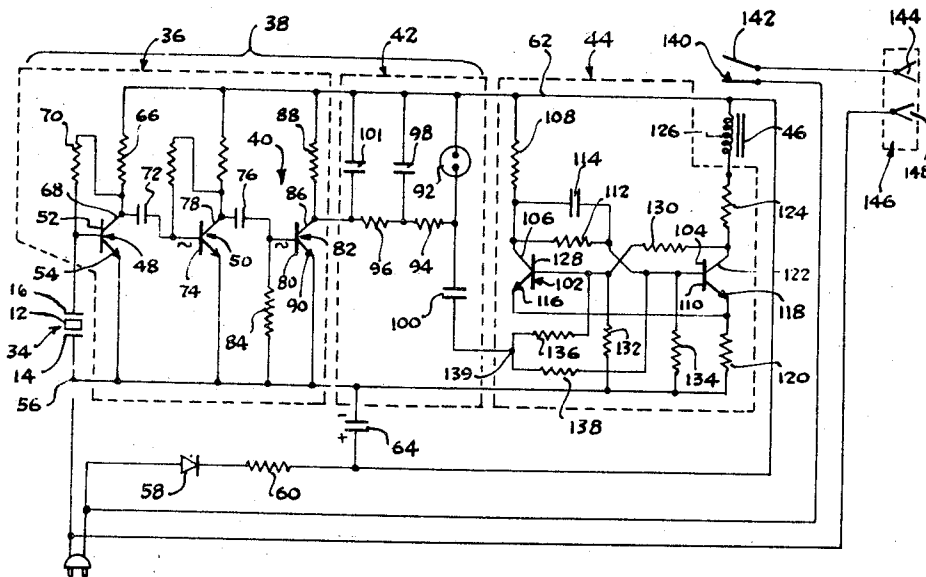


Fig. 1

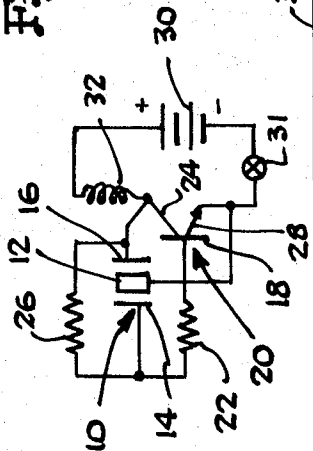
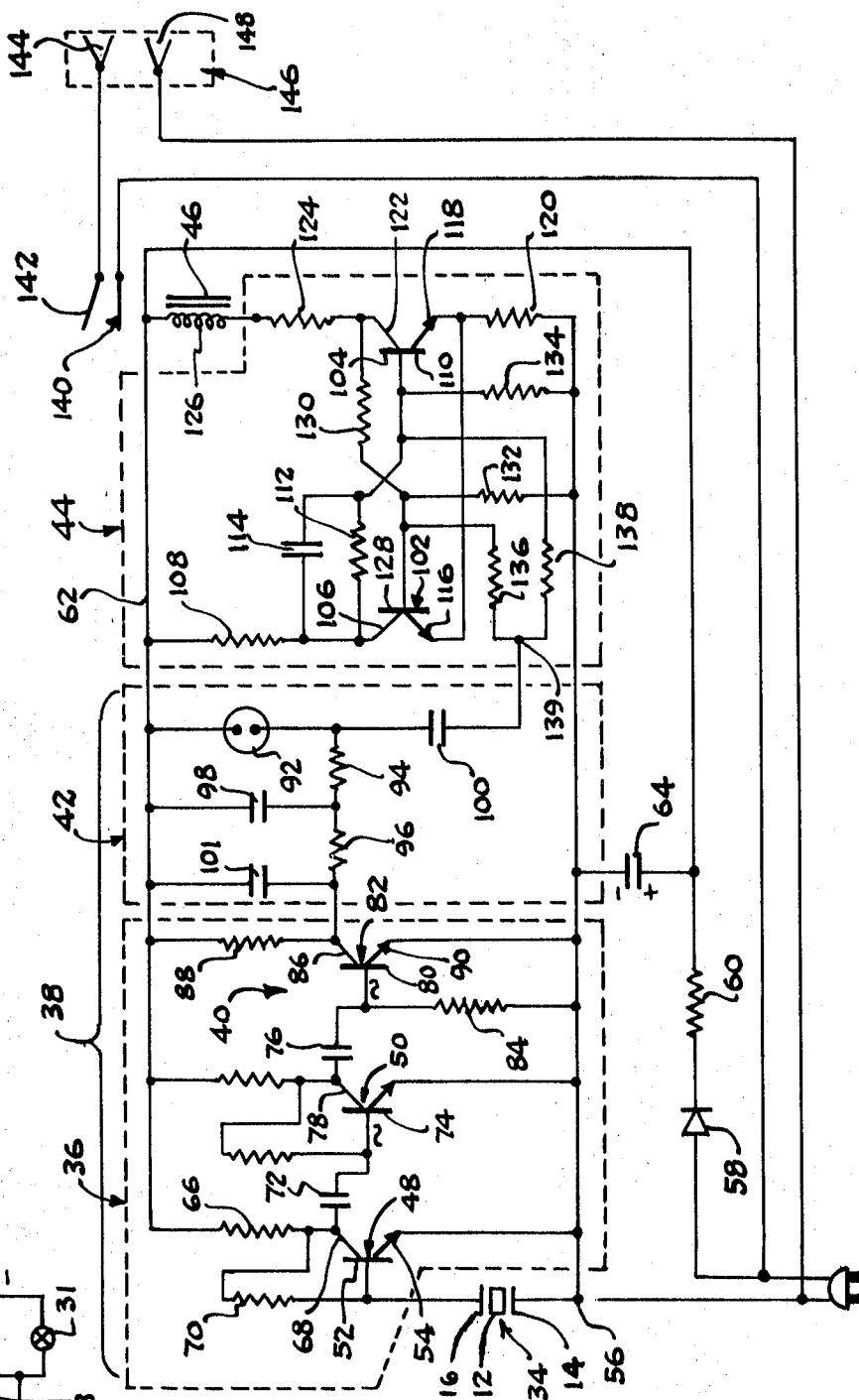


Fig. 2



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REMOTE CONTROL DEVICE

The present invention relates to remote control devices, and more specifically to remote control devices which utilize a portable transmitter and a receiver.

Portable transmitters have been utilized with receivers for remote control purposes for some time. One example of such use is conventional garage door operating remote control equipment. Such equipment generally employs a transmitter mounted in an automobile which may be actuated to effect opening or closing of a garage door. Most conventional garage door remote control units utilize the radio frequencies, and the radio frequency signal from the transmitter is detected by a receiver mounted within the garage. The conventional systems employ a relay which is actuated by the receiver in response to reception of radio waves. The relay then actuates an electromechanical door opening apparatus.

One of the difficulties which is frequently encountered when utilizing radio frequency remote control equipment is that spurious signals actuate the receiver to provide a false actuation of the control mechanism. Radio frequency remote control equipment has been provided with various devices for reducing the probability of a false actuation of the control apparatus, such as impressing a modulation signal on the radio frequency wave or utilizing an interrupted radio frequency wave which must be decoded in the receiver. It is one of the objects of the present invention to provide a remote control system utilizing a transmitter and a receiver which reduces the likelihood of a false actuation and does so both inherently and with a novel coding device.

In accordance with the present invention, ultrasonic radiation is utilized from the transmitter, and this radiation is in the form of an essentially conical beam. Since the radiation from the transmitter is highly directional, the transmitted radiation may be directed toward a known target, thus avoiding the likelihood that this radiation may actuate some other and undesirable remote control receiver. Further, the detecting receiver, in accordance with the present invention, utilizes a transducer for converting the ultrasonic radiation into electrical signals which is itself directional, thereby reducing the probability that the receiver will respond to ultrasonic signals from other directions.

In addition, an ultrasonic receiver constructed in accordance with the present invention utilizes a cycle counting mechanism for actuating a relay which is of unique construction and which prevents spurious signals detected by the receiver from actuating the remotely controlled electromechanical mechanism.

The present invention will be more fully understood and appreciated from a consideration of the following specification, particularly when viewed in the light of the drawings, in which:

FIG. 1 is a schematic electrical circuit diagram of the transmitter of a remote control device constructed according to the teachings of the present invention; and

FIG. 2 is a schematic electrical circuit diagram of a receiver constructed according to the teachings of the present invention.

Referring to FIG. 1, it will be noted that the transmitter or source of ultrasonic energy employs an electroacoustical transducer 10 connected in an oscillator circuit. The oscillator circuit employed is essentially that disclosed in claim by the present inventors and that copending patent application entitled "Motion Detecting Apparatus and Intruder Alarm," File 604-1, Ser. No. 609,514 filed Jan. 16, 1967. The transducer 10 is preferably constructed according to the teachings of U.S. Pat. No. 3,190,111 of Alpha M. Wiggins entitled "Ultrasonic Microphone" issued in Oct. 1963. The transducer has a piezoelectric element 12, diagrammatically illustrated in FIG. 1, which is disposed between two electrodes 14 and 16. Electrode 14 is connected to the base 18 of the transistor 20 through a resistor 22, and the electrode 16 is connected to the collector 24 of the transistor 20. A resistor 26 is electrically connected between the electrodes 14 and 16, and the piezoelectric element 12 is connected to the emitter 28 of the transistor 20. A source of direct current in the form of a bat-

tery 30 has its positive terminal connected to the collector 24 of the transistor 20 through a manually actuable switch 31 and an inductance 32; and its negative terminal connected to the emitter 28 to form a closed electrical circuit including the collector and emitter of the transistor 20. As explained in the aforementioned patent application, the circuit set forth in FIG. 1 will oscillate, and the electroacoustical transducer 10 will itself act as a radiator and emit a beam of radiation at the frequency of oscillation. The transducer 10 also forms the frequency control element of the circuit. While ultrasonic radiation may be usefully produced in this manner and utilized at frequencies of approximately 20 kilocycles and up, the inventors have found that a frequency of 20 kilocycles is particularly useful, both since the electroacoustical transducer is particularly efficient at these frequencies and because the frequencies are substantially above the audible range and do not effect the hearing of humans or animals. In addition, supersonic energy in the range of 40 kilocycles is not common for other purposes, thus further reducing the probability of false actuation of the remotely controlled device.

The receiver illustrated in FIG. 2 is suitable for responding to ultrasonic radiation from the transmitter of FIG. 1. The receiver utilizes an electroacoustical transducer 34 which converts the acoustical energy into an electrical signal. The electrical signal produced by the electroacoustical transducer 34 is amplified by an amplifier 36 which is part of a pulse generating device 38. The pulse generating device 38 also includes a rectifier 40 at its output. The output of the rectifier 40 is in the form of a chain of pulses of a single polarity, and these pulses are utilized by a pulse generating device 42 to actuate a flip-flop 44. The flip-flop 44 controls an electromechanical relay 46 which achieves a switching action. As explained above, the relay 46 may be utilized to control a garage door operator, an electrical light, a television set, or any of the other devices controlled by conventional electrical switches.

The electroacoustical transducer 34 is also preferably constructed in the manner of the ultrasonic piezoelectric transducer disclosed and claimed in U.S. Pat. No. 3,190,111 of Alpha M. Wiggins, referred to above, and identical reference numerals are shown for the electrodes here employed. The piezoelectric ultrasonic transducer 34 is designed to resonate at the same frequency as the transducer 10 of the transmitter, so that the transducer 34 will be particularly sensitive to ultrasonic radiation from the transmitter. Further, the transducer of the receiver 34 is directed toward the direction from which the ultrasonic waves of the transmitter are expected to originate in order to increase the range and probability of true actuation.

The amplifier 36 is a two-stage amplifier employing a first transistor 48 and a second transistor 50. The transducer 34 is electrically connected between the base 52 and emitter 54 of the transistor 48. As indicated in FIG. 1, the receiver utilizes the conventional 110 volt alternating current power lines as a source of power, and one of the power lines forms a common or ground terminal or buss 56, while the other power line is connected to a rectifier 58 to produce a positive potential for the power source. A resistor 60 is connected between the rectifier 58 and a positive buss 62 for the receiver, and a capacitor 64 is connected between the negative buss 56 and the positive buss 64 to reduce voltage fluctuations in the power source.

A resistor 66 is connected between the positive buss 62 and the collector 68 of the transistor 48. The base 52 of the transistor 48 is provided with a positive bias through a resistor 70.

The current flowing in the collector-emitter circuit of the transistor 48 is modulated by the ultrasonic waves detected by the transducer 34, and hence, this current has the same frequency as the ultrasonic waves emitted by the transmitter. This ultrasonic electrical signal is conducted through a capacitor 72 to the base 74 of transistor 50 of the second amplifier stage. The transistor 50 is connected in an essentially identical circuit with transistor 48, and the current flowing through the

collector-emitter circuit of the transistor 50 is merely an amplified alternating electrical signal at the ultrasonic frequency of the transmitter.

A capacitor 76 is connected to the collector 78 of the transistor 50 to conduct this alternating electrical signal appearing in the collector-emitter circuit of the transistor 50 to the base 80 of the transistor 82 of the rectifier 40. The base 80 of transistor 82 is electrically connected to the negative buss 56 through a resistor 84, and the collector 86 of the transistor 82 is electrically connected to the positive buss 62 through a resistor 88. As a result, the base 80 is maintained with a slight positive bias, due to the collector-base current of the transistor 82. The bias on the base 80 of transistor 82 is insufficient to cause a flow of current in the collector-emitter circuit of the transistor 82 in the absence of a positive signal applied to the base 80 of transistor 82. It is to be noted that the emitter 90 of the transistor 82 is connected to the negative buss 56. As a result, the amplified alternating current signal appearing on the base 80 of the transistor 82 when the transducer 34 is receiving ultrasonic radiation from the transmitter results in a rectification action, since only the positive portion of the alternating current wave impressed upon the base 80 causes a flow of current in the collector-emitter circuit of the transmitter 82. The collector 86, in the absence of a signal on the base 80, assumes the potential of the positive buss 62, and the presence of an alternating signal on the base 80 of the rectifier 40 results in a negative pulse appearing on the collector 86 of the transistor 82.

The triggering pulse generator 42 utilizes a neon bulb 92 which has one terminal electrically connected to the positive buss 62 and the other terminal connected to the collector 86 of the transistor 82 through two resistors 94 and 96 connected in series. A capacitor 98 is electrically connected between the junction of the resistors 94 and 96 and the positive buss 62. The chain of negative pulses produced on the collector 86 of the transistor 82 in response to the ultrasonic radiation of the transmitter are thus impressed upon the capacitor 98 as well as the neon bulb 92, and the capacitor 98 must first be charged to the firing potential of the neon bulb 92 before the neon bulb 92 will break down and fire. The size of the resistor 96 and the capacitor 98 are selected with a knowledge of the frequency of the transmitter to provide a suitable time delay before break down occurs in the neon bulb 92. It is desirable that a relatively large number of negative pulses be impressed upon the capacitor 98 and in effect counted, before the capacitor 98 is charged to the firing potential of the neon bulb 92. Since the capacitor 98 is constantly being discharged, intermittent signals detected by the transducer 34 will not achieve an adequate charge of the capacitor 98 to excite the neon bulb 92. When the capacitor 98 is charged to the firing potential of the neon bulb 92, the capacitor 98 is discharged through the neon bulb 92 and the resistor 94, thereby placing a positive potential on the junction between the resistor 94 and the neon bulb 92 relative to the negative buss 56. This positive pulse generated by discharge of the capacitor 98 through the neon bulb 92 is conducted through a capacitor 100 to the input control terminal of the flip-flop 44.

A small capacitor 101 is electrically connected between the collector and the positive buss 62 to bypass high frequency pulses to the common ground. In the particular construction described in this specification, the element of the pulse generator 42 has the following values.

Neon lamp....	92	Type NE 23.
Resistor.....	94	100,000 ohms.
Do.....	96	100,000 ohms.
Capacitor.....	98	2.0 microfarads.
Do.....	101	.01 microfarad.

The transmitter and receiver operate at a frequency of 40 kilocycles.

The flip-flop 44 is a bistable flip-flop which employs two transistors 102 and 104 connected in a conventional flip-flop circuit. The transistor 102 has a collector 106 electrically con-

nected to the positive buss 62 through a resistor 108. The collector 106 is also connected to the base 110 of the transistor 104 through a resistor 112 and a capacitor 114 connected in parallel with the resistor 112. The transistor 102 also has an emitter 116 which is electrically connected to the emitter 118 of the transistor 104, and the emitters 116 and 118 are electrically connected to the negative buss 56 through a resistor 120.

The transistor 104 has a collector 122 which is connected to the positive buss 62 through a resistor 124 and the coil 126 of the relay 46. Also, the collector 122 of transistor 104 is connected to the base 128 of transistor 102 through a resistor 130. The base 128 of transistor 102 is connected to the negative buss 56 through a resistor 132, and the base 110 of transistor 104 is connected to the negative base 56 through a resistor 134.

The bases 128 and 110 of the transistors 102 and 104 are connected to resistors 136 and 138, respectively, and the resistors 136 and 138 are electrically interconnected at 139 remote from the transistors to form the control input terminal of the flip-flop 44. The capacitor 100 is connected to this control input terminal, that is, the junction between the resistors 136 and 138. The positive pulse appearing across the resistor 94 is transmitted through the capacitor 100 to the bases 128 and 110 of the transistors 102 and 104. A flow of current exists in the collector-emitter circuit of one and only one of the transistors 102 and 104 in each of the stable states of the flip-flop 44, and the presence of a positive pulse on the base of the nonconduction transistor causes that transistor to commence conduction in its collector-emitter circuit and also ultimately results in cutting off the flow of current through the collector-emitter circuit of the other transistor. If it is assumed that current is flowing through the collector-emitter circuit of the transistor 104 will not be energized, and the contacts of the relay, designated 140 and 142, will be open. A pulse impressed upon the bases 128 and 110 of the transistors 102 and 104 will result in a flow of current through the collector-emitter circuit of the transistor 104, and hence the coil 126, thus closing the contact 140 and 142.

The contacts 140 and 142 are connected in series with one terminal 144 of a receptacle 146 and one of the power lines to control the flow of current to the terminal 144. The other terminal 148 of the receptacle 146 is directly connected to the other power line. Hence, a mechanism to be controlled, such as a garage door operator, or an electric light may be plugged in the receptacle 146 and subjected to control by the transmitter. When the switch 31 of the transmitter is closed, the relay 44 will change positions, regardless of its previous position due to the fact that the flip-flop 44 is bistable.

Those skilled in the art will readily find many applications for the present invention in addition to that herein disclosed for example, the pulse generator 42 may be utilized with radio waves or another source of pulses, as well as with ultrasonic radiation as illustrated. However, the frequency of ultrasonic radiation permits the cycles of the radiation waves to be counted in the pulse generator 42, while eliminating spurious responses, thus simplifying the construction and reducing the cost of the receiver. It is therefore intended that the scope of the present invention be not limited by the foregoing disclosure, but rather only by the appended claims.

The invention I claim is:

1. A remote control receiver responsive to an actuable and deactuable source of ultrasonic wave energy,
- 65 comprising an electroacoustical transducer having a piezoelectric member responsive to ultrasonic radiation and mounting means for causing said piezoelectric member to resonate at the frequency of the source, said transducer producing electrical signals corresponding in frequency to the source,
- 70 an amplifier connected to said transducer for producing amplified signals corresponding to said electrical signals,
- a rectifier connected to the output of said amplifier for producing unidirectional pulses corresponding to said amplified signals,
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a counter including a storage capacitor and a charging resistor connected between said rectifier and said capacitor for causing said unidirectional pulses to charge said capacitor over a period of time,
a control pulse generator including a gaseous discharge tube 5
connected across said capacitor for abruptly discharging said capacitor through said tube and thereby producing a brief control pulse in response to the charging of said capacitor by said unidirectional pulses to a threshold voltage sufficient to break down said tube, 10
a bistable electronic switch connected to the output of said control pulse generator and operable by said control pulse,
said bistable electronic switch having two stable states and 15

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being operable by said control pulse from either state to the other state,
and a utilization device, connected to and operable by said bistable electronic switch.
2. A remote control receiver according to claim 1,
in which said control pulse generator includes a second resistor in series with said gaseous discharge tube for developing said control pulse as a voltage drop across said second resistor when said capacitor is abruptly discharged through said tube and said second resistor.
3. A remote control receiver according to claim 1,
in which said bistable electronic switch comprises a bistable flip-flop.

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