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REMOTE CONTROL BY PLURAL CONCURRENT DIVERSE TYPE SIGNALS

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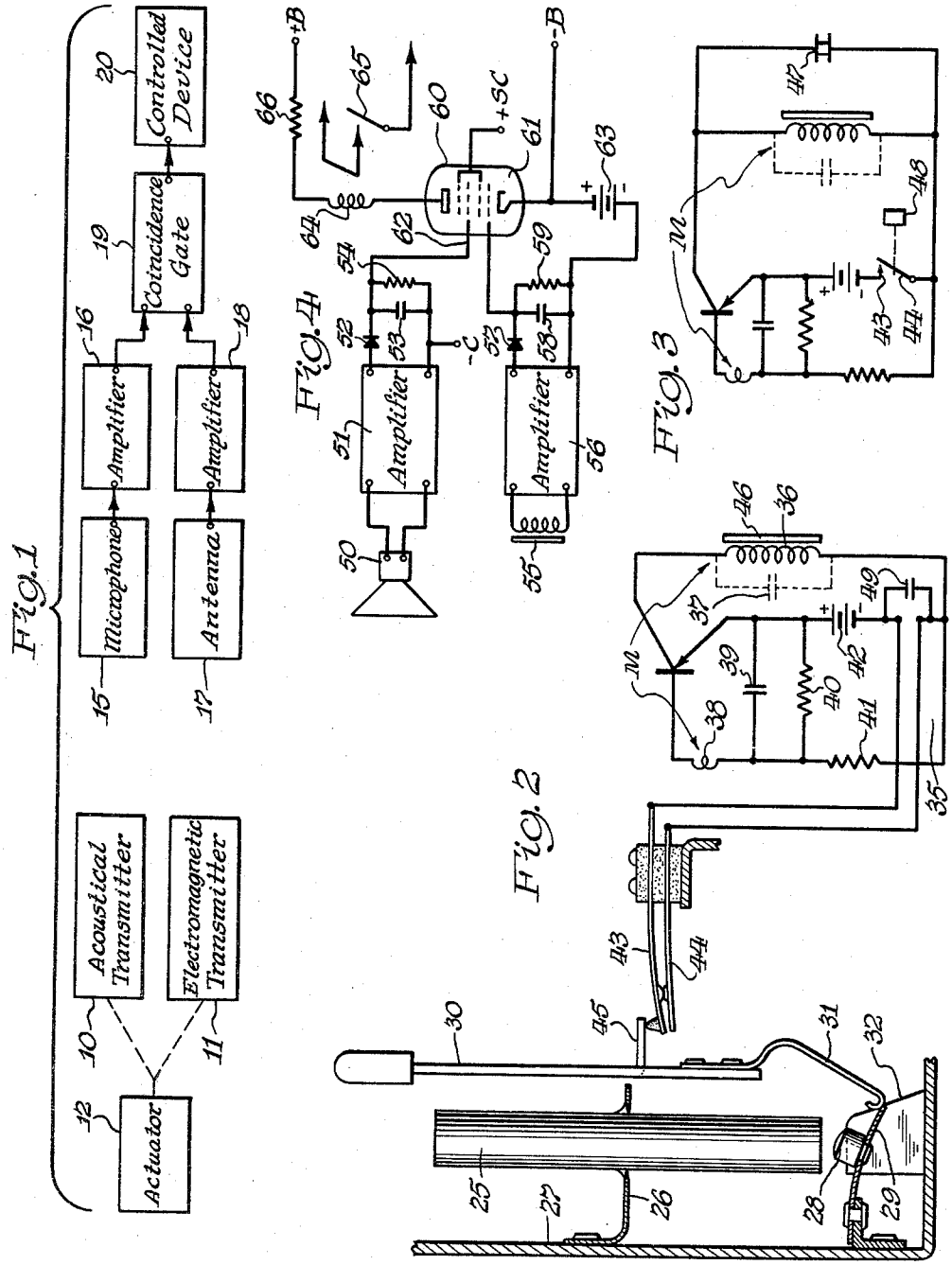


FIG. 1

FIG. 4

FIG. 3

FIG. 2

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REMOTE CONTROL BY PLURAL CONCURRENT DIVERSE TYPE SIGNALS

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This invention relates to remote control systems and is particularly addressed to safeguarding such a system against false actuation.

Remote control systems have long been known and have been proposed for a variety of applications, such as adjusting the operating characteristics of a wave signal receiver, for industrial controls, for opening garage doors, and the like. In general, they comprise a signal generator which is located at a point remote to the device or mechanism that is to be controlled but effectively coupled thereto by means of a signal path having characteristics determined by the nature of the control signal employed. While some systems feature a conductive connection from the remote location to the controlled station, they are subject to obvious disadvantages and, indeed, are in much less favor than systems in which the control signal is radiated to the controlled station.

The last-mentioned type of system is very flexible in use and is free of objectionable hazards incident to cable connections extending to the remote location, but it is undesirably subject to false actuation for the simple reason that unsophisticated control gear is not able to distinguish between a control signal and a spurious radiation of the same or nearly the same frequency as the control signal. Efforts have been made to secure the controlled device against false actuation, one successful arrangement being described in United States Letters Patent 2,817,025, issued December 7, 1958, in the name of Robert Adler and assigned to the same assignee as the present invention.

In the arrangement disclosed in that patent, a comfortable margin of safety against spurious actuation is achieved by having the control device highly selective as to both the frequency and the duration of the control signal. That is to say, for the device to respond to a received signal, that signal must satisfy two requirements: (1) it must fall within the narrow frequency band which the receiving device accepts, and (2) it must have a duration at least equal to some preselected minimum value. Since it is highly unlikely that spurious radiations will satisfy both such requirements, the arrangement is rendered adequately secure for most installations.

Other systems which are less successful in protecting against fortuitous actuation place reliance entirely upon frequency selectivity. They have been designed, for example, to have an extremely narrow acceptance band, requiring an actuating signal to fall within narrow frequency limits if it is to be effective. Additionally, the highly selective radio-frequency circuits are sometimes followed within the receiver by other circuits which are selective to a narrow band of modulating frequencies, but these systems are nonetheless subject to false actuation should a spurious signal have the correct frequency character.

Even where acceptable security against false actuation has been achieved in the past, it has been at the expense of some added equipment and there is a need for an alternative approach which affords suitable protection against false actuation without imposing any great apparatus complexity. Industrial applications would benefit from such a system and it may be equally useful for the remote control of appliances and wave signal receivers for use in the home.

It is, accordingly, an object of the present invention to provide a novel remote control system which is secure against false actuation even though it relies upon the radiation of energy from a remote point to the controlled device.

It is a specific object of the invention to provide a remote control system of simplified and inexpensive construction and yet characterized by freedom from actuation by spurious signals which may be encountered at the remote location.

A remote control system, constructed in accordance with the teachings of the invention, comprises a transmitter for radiating signal energy of a first type and another transmitter for radiating signal energy of a second and different type. Unicontrol means are provided for actuating the transmitters to effect radiation from both and the system has means, including a pair of receivers respectively responsive to the two types of signal energy, for developing a pair of control effects. Finally, the system has means responsive only to the conjoint application or influence of both control effects for actuating the controlled or utilization device.

The features of the invention which are believed to be new are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in conjunction with the accompanying drawings, like components of which (in the several figures) are designated by similar reference characters, and in which:

FIGURE 1 is a block diagram of a remote control system constructed in accordance with the invention;

FIGURES 2 and 3 represent two apparatus embodiments of transmitting arrangements suitable for use in the system represented in FIGURE 1; and

FIGURE 4 is a representation, partially schematic, of a receiving system which may be employed in the remote control of FIGURE 1.

Referring now more particularly to FIGURE 1, the remote control system there represented comprises a pair of transmitters **10** and **11** for radiating two different types of signal energy to a receiving system characterized by the fact that it responds only to the joint influence of a plurality of received signals individually representing different, and preferably concurrently received, types of signal energy. Such a characteristic endows the system with a unique measure of security against false actuation because of the extreme improbability that radiations of two preselected and different kinds of energy will be concurrently encountered in the usual receiving location. A variety of combinations of energy transmitters readily suggest themselves because of the different types of energy transmitters that may be conveniently and inexpensively constructed and operated. One may advantageously employ any combination of transmitters which individually emit electromagnetic, acoustical, light (whether polarized or not) and similar radiations. As shown, transmitter **10** radiates acoustical energy while transmitter **11** radiates electromagnetic energy. These have been selected merely as an illustrative combination and also because they represent a very practical approach to the transmitter system. The energy radiated by transmitters **10** and **11** is pulsed and may be of the same or different frequencies.

An actuator **12** constitutes means for actuating both transmitters to effect radiation therefrom. As will be apparent in the discussion of subsequent figures, the actuator may conveniently be a simple unicontrol mechanism for pulsing the transmitters. Where the acoustical transmitter takes the form of a mechanical resonator, such as a mechanical vibrating element or rod, it may be excited by a striker which is actuated to impact the vibrator and

where transmitter **11** is an oscillator coupled to a radiating antenna, it may be excited by the operation of a circuit-closing switch. In such case, actuator **12** may be a simple mechanical linkage interconnecting the striker mechanism of the acoustical transmitter and the switch of the electromagnetic transmitter, both of which are operated under the control of a single pushbutton to excite the transmitters throughout a common control interval.

The energy radiated by the transmitters is intercepted by a pair of receivers respectively responsive to the two types of radiation that are transmitted. The receiver for responding to the acoustical or sonic radiation includes a microphone **15** coupled to an amplifier **16** while the receiver for intercepting the electromagnetic radiation includes an antenna **17** feeding an amplifier **18**. Amplifiers **16** and **18** may be more or less selective, as desired, but for the simplest and least expensive installation, they may be relatively nonselective and considerable security against false actuation is nevertheless attained.

Energy picked up by microphone **15** and antenna **17** is manifest in a pair of control effects developed at the output circuits of amplifiers **16** and **18**, which circuits are connected to a coincidence gate **19**. The coincidence gate serves as means which is responsive only to the conjoint application of control effects from both receivers for actuating a utilization or controlled device **20**. Device **20** may be a wave signal receiver or any of a variety of devices desired to be controlled as to some operating characteristic from a remote point. Whether that characteristic be an on-off condition, the tuning, volume, or anything else is of no particular concern for the simple reason that the control system under consideration exercises a control influence that is useful in a myriad of applications.

The coincidence gate **19** may take any of a variety of well-known forms. An elementary coincidence device suitable for use in the system comprises a pair of relays each of which responds to an output signal from one of amplifiers **16**, **18** to control an associated one of two switches arranged in series in the circuit to be controlled. Alternatively, a multi-grid tube having two control electrodes and biased to a condition of anode current cut off in the absence of a received signal applied to each of the control grids is very acceptable for use as a coincidence gate.

In considering the operation of the described system, it will be assumed that the transmitter **10–12** is at a point removed from but in the same general location as receiving system **15–20** which will, in turn, be assumed to be a portion of a remote control television receiver. It will further be assumed that unit **20** is the tuning mechanism of the receiver which is under the control of the output signal of coincidence gate **19** to change the tuning from one station or channel to the next. A receiver having that characteristic and including a tuning mechanism which lends itself particularly well to this type of remote control is disclosed in the aforesaid patent, No. 2,817,025.

If the receiver has been turned on and is reproducing a picture in response to a broadcast received over one television channel, it may be tuned to a different channel upon the operation of actuator **12**. Actuator **12** energizes both acoustical transmitter **10** and electromagnetic transmitter **11**, causing a pulse of sonic energy and a pulse of electromagnetic energy to be radiated from a remote point. The sonic energy is picked up by microphone **15** and is converted into a control effect or signal which is amplified in amplifier **16** and applied to one input signal of coincidence gate **19**. The electromagnetic energy is intercepted by antenna **17**, amplified in amplifier **18** and applied to the other input circuit of coincidence gate **19**. Control signals are thus applied concurrently or simultaneously to the coincidence gate which is operated in response thereto and delivers an actuating signal to controlled device **20**. This results in actuation of the controlled device or tuner **20**. The tuner will, in the usual installation, be motor-driven and the actuating signal from

coincidence gate **19** energizes the driving motor to step the tuner from one operating position in which it accepts one television channel to a succeeding operating position in which it selectively accepts a different television channel.

The system is extremely simple in construction and provides adequate safeguard against false actuation because in the usual location it is most unlikely that a spurious electromagnetic radiation will be experienced concurrently with an acoustical radiation and both are necessary to actuate coincidence gate **19**. As previously indicated, an increased measure of security may be realized by tuning the system, requiring that the acoustical energy and that the electromagnetic energy individually fall within a narrow frequency band to be accepted by amplifiers **16**, **18**. Then, of course, the amplifiers may be tuned to the same or to different frequencies.

The system may be envisaged as one requiring two different radiations, the first of which arms or conditions the controlled receiving system to respond to the second. The electromagnetic pulse, for example, may be thought of as arming the receiver so that it might respond to the pulse of sonic energy. If desired, additional protection against false actuation may be achieved by requiring, not only an arming signal of one type of energy (electromagnetic) but also a combination of signals of another type of energy, such as, two or more sonic signals individually having a distinct frequency.

It is realized that the propagation velocities of sonic energy and electromagnetic energy are distinctly different, and the electromagnetic energy arrives at antenna **17** before the arrival of the sonic energy at microphone **15**. If the pulse durations are sufficiently long, there will be a time interval in which they overlap or coexist and this may be thought of as a common control interval. It is a common control interval for the reason that it represents a time interval in which both inputs of coincidence gate **19** concurrently receive control signals from receivers **15**, **16** and **17**, **18**. It is not essential, however, that the pulses of energy in fact have time coincidence. For example, should the electromagnetic energy be received before the sonic energy, it is a simple matter to include a time-delay network in the receiver, following amplifier **18**, to delay the control signal therefrom. Appropriate selection of the delay introduced by the time-delay network results in effective simultaneity of the signals at coincidence gate **19**. An essentially similar result may be obtained without the use of time-delay networks if a relay which is closed in the coincidence circuit at the time the first control signal arrives holds for a suitable period to accommodate a delay experienced in the propagation of the other control signal to the receiving station.

Two different types of transmitter arrangements, suitable for inclusion in the system of FIGURE 1, are represented in FIGURES 2 and 3. The arrangement of FIGURE 2 employs an acoustical transmitter which may be the same in all material respects as that disclosed and claimed in United States Letters Patent 2,821,955, issued February 4, 1958, to R. C. Ehlers et al. and assigned to the same assignee as the present invention. It includes a cylindrically-shaped longitudinal-mode resonator or vibrator **25** centrally supported in a bracket **26** which is, in turn, secured to a mounting plate **27**. A striker **28** is supported in proximity to but spaced from the lower end of resonator **25**, the striker being carried upon a resilient member or leaf spring **29** in turn secured to support plate **27**. A pushbutton actuated lever **30** terminates in a resilient element **31** having a path of travel to engage the free end of leaf spring **29** and displace it for the purpose of striking rod **25** with striker **28**. Release of leaf spring **29** from engagement with member **31** is under the control of a cam surface **32**. When the pushbutton-operated lever **30** is depressed vertically downwardly, member **31** deflects leaf spring **29** and striker **28** downwardly, cocking them to develop a

thrust for percussively driving the striker against rod 25. As the pushbutton-actuated rod engages cam plate 32, it deflects element 31 to release spring 29 so that striker 28 is driven home against the vibrator.

The electromagnetic transmitter portion of the arrangement of FIGURE 2 comprises a conventional oscillatory circuit 35 employing a P–N–P junction type of transistor. The operating frequency is determined by a resonant circuit including an inductor or coil 36 and a tuning capacitance 37 shown in dotted-line representation since it may be comprised in whole or in part of distributed capacitance. Feedback results from a coupling between coil 36 and a coil 38 connected to the base electrode of the transistor, their coupling being represented by the symbol "M." Condenser 39 serves as a by-pass, and resistors 40 and 41 constitute a voltage divider across a battery 42. The oscillatory circuit is normally disabled by a switch having contacts supported on leaf springs 43 and 44 and by-passed at the operating frequency by a condenser 49. A switch actuator 45 of L-shaped configuration is carried upon push-button-actuated lever 30 to close contacts 43, 44 when the pushbutton is depressed, as described above. Electromagnetic oscillatory energy is radiated by means of a magnetic dipole provided by the winding 36 and a ferromagnetic rod or cylinder 46 about which the winding is coiled.

The operation of this transmitter is as follows: actuation of pushbutton lever 30 closes contacts 43, 44 and completes the circuit of the oscillator to initiate radiation of electromagnetic energy at an operating frequency determined by the resonant frequency of tuned circuits 36, 37. Advancement of lever 30 also cocks leaf spring 29 and then releases it to permit striker 28 to impinge upon the lower end of rod 25 and thus emit a pulse of sonic energy having a frequency determined by the physical dimensions of the rod. The sonic radiation and the electromagnetic radiation may have the same or different frequencies, as desired. The pushbutton lever is spring biased to a normal or at rest position to which it returns when it is released. Its return opens the oscillator circuit and resets both the sonic and electromagnetic transmitters for the next operation of the remote control.

A composite acoustical and electromagnetic transmitter is shown in FIGURE 3, differing from that of FIGURE 2 primarily in that the acoustical transmitter is electrically rather than mechanically operated. The arrangement of this embodiment includes an oscillatory circuit essentially the same as that of FIGURE 2, but also having a transducer 47 connected in parallel with tuned circuits 36, 37. Transducer 47 may take the form of a disc or cylindrical element constructed of a piezoelectric material such as barium titanate which is set into mechanical vibration in response to an applied oscillatory potential. The wafer has electrodes on opposite surfaces thereof and is permanently polarized longitudinally. It is a longitudinal-mode vibrator emitting a sonic radiation similar to that of vibrator 25 of FIGURE 2. In the arrangement of FIGURE 3, switch 43, 44 is pushbutton actuated, as indicated schematically at 48. When the switch is closed and oscillations are established, electromagnetic and sonic radiation is achieved but, in this instance, the two signals have the same frequency.

An illustrative type of receiver arrangement is indicated in FIGURE 4. The receiver of sonic energy includes a microphone 50 coupled to an amplifier 51 which may advantageously be tuned to the energy of sonic radiation emitted by vibrator 25 of FIGURE 2 or transducer 47 of FIGURE 3. The amplified energy is applied to a detector or rectifier circuit comprising a germanium diode 52 having a load circuit provided by a condenser 53 and a resistor 54. The receiver of electromagnetic energy comprises an antenna 55 shown as a magnetic dipole similar to that included in the transmitters of FIGURES 2 and 3. The antenna is connected to the input terminals of an amplifier 56, preferably tuned to the operating frequency of the oscillator of FIGURE 2 or 3. A similar detector circuit is coupled to this amplifier, comprising a germanium diode 57 and a load circuit provided by a condenser 58 and a resistor 59. The coincidence gate is a multi-electrode discharge device or tube 60 having a first control electrode 61 and a second control electrode 62. Control electrode 61 is connected to the load circuit of diode 57 while control electrode 62 connects to diode 52.

Tube 60 is normally biased to cut off by virtue of a "C" bias battery 63 included in both grid return circuits and both diode circuits 52 and 57 are returned to —C. The anode circuit of tube 60 includes the excitation winding 64 of a relay having an armature 65, and the anode receives an operating potential from a source +B through a resistor 66. The circuit which is controlled by the receiving system is not shown but includes a switch having armature 65 as its movable element. Since tube 60 is normally biased to anode current cut-off, there is no current flow through solenoid coil 64 and switch 65 is on open circuit. The reception of sonic energy in microphone 50 and of electromagnetic energy by antenna 55 results in the coincidence of control potentials of positive polarity to control electrodes 61 and 62 of tube 60. Tube 60 is rendered conductive and the solenoid coil is energized, closing switch 65 and actuating the controlled device (not shown).

The described arrangements all employ radiations of at least two types to actuate the device subject to the remote control and this assures considerable safeguard against false actuation as explained above. Greater security is achieved by tuning the system and still further protection may be attained by requiring timed reception of three or more different kinds of radiated energy. Generally, however, use of two different kinds of energy will be sufficient.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A remote control system for permitting an operator to control a function of a utilizing device from a remote point, comprising: a first receiver responsive to signal energy of a first type for developing a first control signal; a second receiver responsive to signal energy of a second and different type for developing a second control signal; a utilizing device for performing a predetermined function; coincidence means responsive only to the conjoint application of said first and second control signals for actuating said utilizing device to perform said predetermined function; and remote control transmitting apparatus remotely located and entirely separate from said utilizing device and including a first transmitter for producing and radiating signal energy of said first type to said first receiver, a second transmitter for producing and radiating signal energy of said second type to said second receiver, and uni-control means for actuating said first and second transmitters to effect radiation from both in order to effect actuation of said utilizing device.

2. A remote control system for permitting an operator to control a function of a utilizing device from a remote point, comprising: a first receiver responsive to sonic energy for developing a first control signal; a second receiver responsive to electromagnetic energy for developing a second control signal; a utilizing device for performing a predetermined function; coincidence means responsive only to the conjoint application of said first and second control signals for actuating said utilizing device to perform said predetermined function; and re-

mote control transmitting apparatus remotely located and entirely separate from said utilizing device and including an acoustical transmitter for producing and radiating sonic energy to said first receiver, an electromagnetic transmitter for producing and radiating electromagnetic energy to said second receiver, and means for actuating said first and second transmitters to effect radiation from both said transmitters throughout a common time interval in order to effect actuation of said utilizing device.

3. Remote control apparatus comprising a dual path control signal transmitter including a manually operable actuating device, means for simultaneously producing an acoustic signal and an electrical field signal by manual actuation of said device, and dual control signal responsive means spaced from said transmitter comprising means responsive only to the simultaneous reception of said two signals to operate a control device, said last means including means separately responsive to each of said two signals.

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