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Hulsbosch et al.

[11] **3,798,601**

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[54] **REMOTE CONTROL SYSTEM**

[75] Inventors: **Cornelis Jozef Hulsbosch; Dirk Nederlof,** both of Emmasingel, Netherlands

[73] Assignee: **U.S. Philips Corporation,** New York, N.Y.

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[52] **U.S. Cl.** .... **340/148,** 340/171 PF

[51] **Int. Cl.** **H04b 1/68**

[58] **Field of Search**.... 340/148, 171, 167 A, 171 R, 340/171 PF; 325/37; 179/84 VF, 90 K

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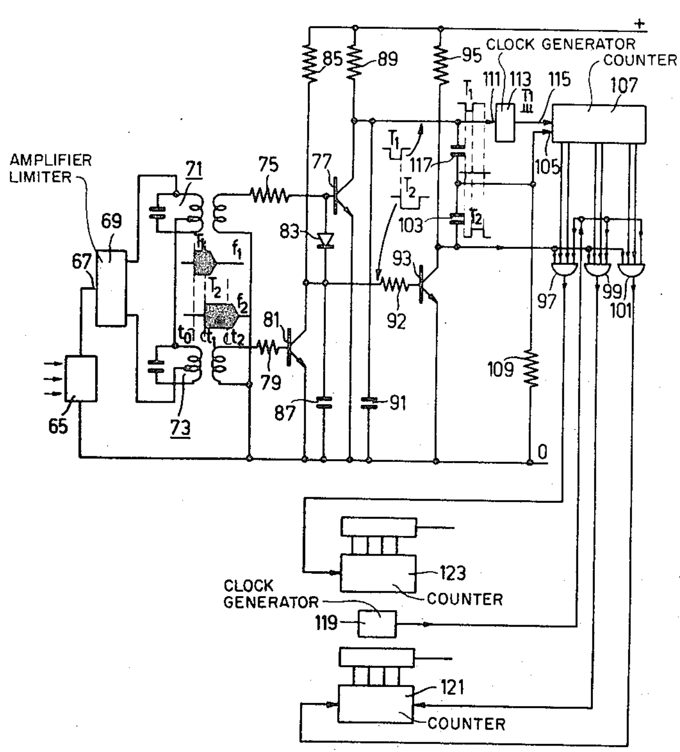
Primary Examiner—Donald J. Yusko
Attorney, Agent, or Firm—Frank R. Trifari

[57] **ABSTRACT**

An ultrasonic remote control system in which the influence of echoes on a pulse duration information transmission is prevented by using signals having a first and a second frequency and in which the occurrence of the signal having the first frequency determines the commencement of the pulse duration information and the occurrence of the signal having the second frequency determines the end of this information.

10 Claims, 2 Drawing Figures



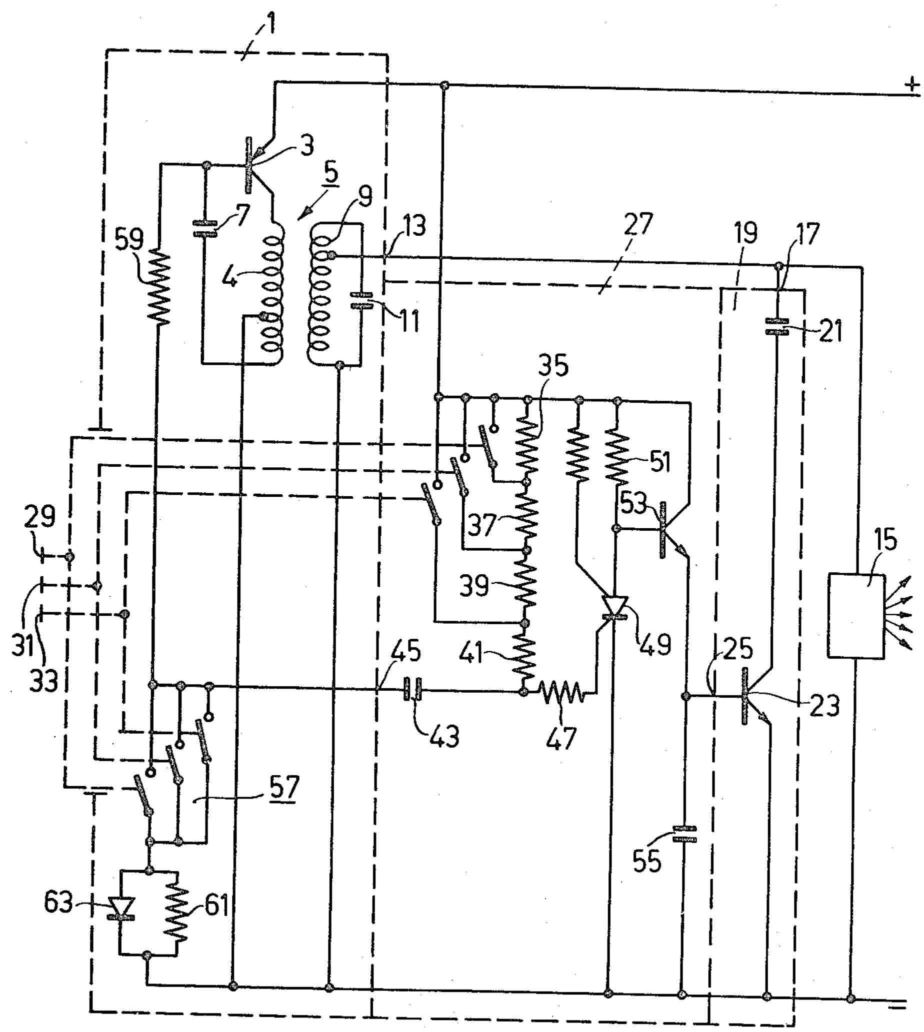

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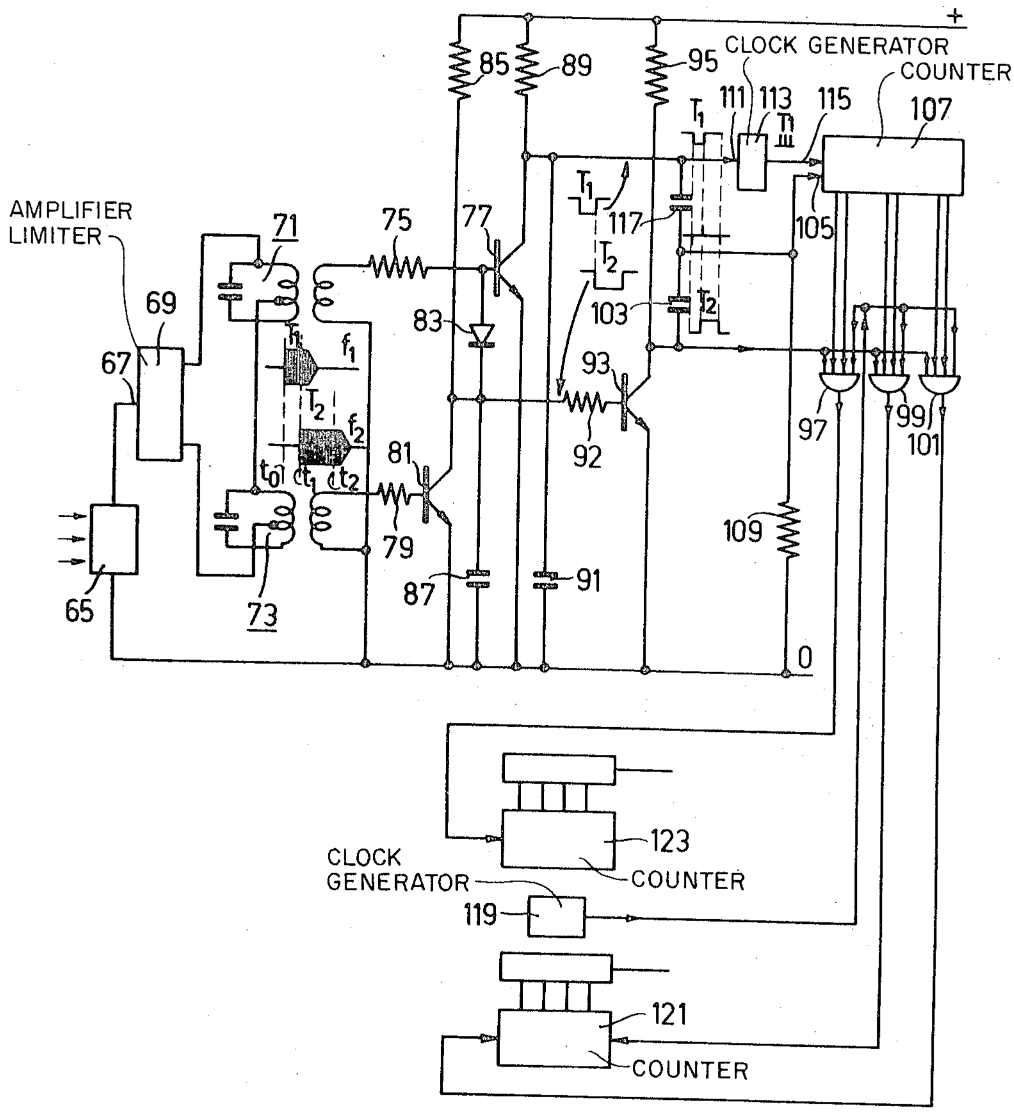
Fig.1


CLOCK GENERATOR
COUNTER
AMPLIFIER
LIMITER
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103
105
107
109
111
113
115
117
119
121
123
COUNTER
CLOCK
GENERATOR
COUNTER
0
+

Fig.2

REMOTE CONTROL SYSTEM

The invention relates to a remote control system which utilizes ultrasonic pulse duration information transmission from a transmitter to a receiver for at least partial remote control of a remote control device coupled to the receiver. Furthermore the invention relates to a transmitter and a receiver for this system.

A remote control system of the kind described above is known from U.S. Pat. No. 3,098,212 in which an ultrasonic signal having a given pulse duration transmitted at a given frequency by the transmitter is to excite a corresponding function selection switch in the receiver.

As a result of reflections occurring in most rooms the pulse duration of the signal to be processed by the receiver is, however, greatly dependent on the relevant room so that a uniform function selection is difficult to realize.

To obviate this drawback a remote control system of the kind described in the preamble, according to the invention, is characterized in that the remote control system includes means for transmitting the pulse duration information by means of the time difference between the transmission of a first ultrasonic signal of a first frequency and a second ultrasonic signal of a second frequency.

A transmitter for a remote control system according to the invention is characterized in that the transmitter includes a frequency change-over circuit coupled to the generator circuit, which frequency change-over circuit is coupled to a time delay circuit determining the pulse duration information. A receiver for such a system is characterized in that it includes a first signal path coupled to the input of the receiver and having a first filter tuned to the first frequency and a second signal path coupled to the input of the receiver and having a second filter tuned to the second frequency. The first signal path furthermore includes a gating circuit an operating signal input of which is coupled to an output of a first detection circuit an input of which is coupled to an output of the second signal path. The commencement of the pulse duration is then determined by the commencement of the occurrence of a signal having the first frequency and the end of the pulse duration is determined by the commencement of the occurrence of a signal having the second frequency. Since, for example, the initial periods of these signals have corresponding properties at the receiver input, which properties remain correspondence when reflections occur, a very defined pulse duration transmission is possible with a system according to the invention.

The invention will now be described with reference to the accompanying drawing in which:

FIG. 1 shows by way of a non-detailed circuit diagram a transmitter for a remote control system according to the invention, and

FIG. 2 shows by way of a non-detailed circuit diagram a receiver for a remote control system according to the invention.

FIG. 1 shows a generator circuit 1 which is suitable for generating a signal of ultrasonic frequency, for example, in the order of 40 kHz. The generator circuit 1 has a pnp transistor 3 the emitter of which is connected to a positive terminal + of a supply source and the collector of which is connected through a tapped winding 4 of a transformer 5 to a further terminal − of the supply source. The other end of the winding 4 is connected through a capacitor 7 for alternating voltage to the base of the transistor 3 and constitutes together with this transistor 3 a so-called three-point oscillator circuit. A second winding 9 of the transformer 5, together with a capacitor 11 connected thereacross, constitutes a tuned circuit which determines the generator frequency. This second winding is connected at one end to the − terminal and at the other end to the tap on an output 13 of the generator circuit 1.

The output 13 is connected to an ultrasonic sound reproducer 15 and furthermore to a connection 17 of a frequency change-over circuit 19.

The connection 17 of the frequency changeover circuit 19 is connected to the O terminal through the series arrangement of an additional tuning capacitor 21 and the collector-emitter path of an npn transistor 23.

The base of transistor 23 is connected to an output 25 of a time delay circuit 27.

The time delay circuit 27 includes a time-constant network which can be changed over by function selection members 29, 31, 33 and which is constituted by a series arrangement of four resistors 35, 37, 39 and 41 and a capacitor 43. This series arrangement is connected at one end to the positive supply voltage + and at the other end to a connection 45 of the generator circuit.

The connection between the resistor 41 and the capacitor 43 is connected through a resistor 47 to the control electrode of a thyristor 49 whose anode is connected through a resistor 51 to the positive supply voltage. The anode of thyristor 49 is also directly connected to the base of an npn transistor 53 and its cathode is connected to the 0 terminal. The collector of the transistor 53 is connected to the positive supply voltage and the emitter is connected to the base of the transistor 23 which is decoupled for interference voltages through a capacitor 55.

The connection 45 of the generator circuit is connected at one end to a group 57 of parallel-arranged contacts operable by the function selection members 29, 31, 33 and end to a resistor 59 connected to the base of the transistor 3.

The group 57 of parallel-arranged contacts is connected to the 0 terminal through a parallel arrangement of a resistor 61 and a diode 63 serving for supply voltage compensation.

The operation of the transmitter is as follows.

In the position of the function selection members 29, 31, 33 shown and the contacts coupled therewith, the emitter of the transistor 3 cannot convey current. The connection 45 of the generator circuit is then connected through the emitter-base junction of the transistor 3 and the resistor 59 to a positive voltage and the generator circuit does not operate. The thyristor 49 will conduct due to the high voltage which is present at the control electrode. The base of the transistor 53 has a low voltage so that the transistor 23 is then cut off.

When a function selection member 29, 31, 33 is depressed one of the contacts of group 57 is closed, the transistor 3 can draw current and the generator circuit 1 starts to oscillate. Simultaneously the potential of the junction between the capacitor 43, the resistor 41 and the resistor 47 suddenly decreases with a voltage step which is equal to the voltage drop across the connection 45 occurring as a result of closing one of the contacts of the group 57. The thyristor 49 is then cut off and the voltage at the base of the transistor 53 increases so that this transistor starts to conduct and causes the transistor **23** to conduct whereupon the capacitor **21** decreases the resonant frequency of the circuit **9, 11** and the generator circuit **1** provides its first frequency f_1.

As a result of a current flowing through the resistor **41,** the value of which current depends upon which of the function selection members **29, 31** or **33** is depressed, the capacitor **43** is charged and the voltage at the control electrode of the thyristor **49** increases until this thyristor starts to conduct and switches off the capacitor **21** by blocking the transistors **53** and **23.** The resonant frequency of the circuit **9, 11** is increased then and the generator circuit **1** provides its second frequency f_2 as long as one of the function selection members remains depressed.

The period of time elapsing between the occurrence of the first and the second frequency is dependent on which of the function selection members **29, 31** or **33** is depressed and thus provides information relating thereto. As a result of the parallel arrangement of the diode **63** and the resistor **61** this period is furthermore substantially independent of supply voltage variations.

A second piece of information which is transmitted is the period of occurrence of the second frequency, which is determined by the period that the relevant function selection member remains depressed.

Although in the foregoing an extremely simple combination of a generator circuit, a time delay circuit and a frequency change-over circuit is described, it will be evident that numerous different combinations capable of fulfilling the described functions can be used. It is alternatively possible to first transmit a high frequency and then a low frequency.

If desired, for example, mechanical time delay circuits may be used and/or more frequencies may be transmitted one after the other.

FIG. **2** shows an ultrasonic sound recorder **65** connected to an input **67** of an amplifier and limiter **69** which has an output circuit having two tapped series-arranged circuits **71** and **73** tuned to different frequencies f_1 and f_2. A secondary winding of the first circuit **71** is connected at one end through a resistor **75** to the base of an npn transistor **77** and at the other end to a zero terminal **0** of the supply voltage. A secondary winding of the second circuit **73** is connected at one end through a resistor **79** to the base of an npn transistor **81** and at the other end likewise to the zero terminal.

The signal path from the input **67** of the amplifier **69** to the base of the transistor **77** is referred to as the first signal path, that from the input **67** to the base of the transistor **81** is referred to as the second signal path.

The connection between the resistor **75** and the base of the transistor **77** is connected to the anode of a diode **83** which constitutes a gating circuit with the resistor **75.** The cathode of diode **83** is connected to the collector of the transistor **81** which is furthermore connected through a resistor **85** to a positive supply voltage + and through a detection capacitor **87** for ultrasonic alternating voltages to the zero terminal **0.** The connection between the collector of the transistor **81** and the cathode of the diode **83** constitutes the operating signal input of the gating circuit. The transistor **81** constitutes, together with the resistor **85** and the capacitor **87,** a detection circuit.

The collector of the transistor **77** is connected through a resistor **89** to the positive supply voltage + and through a detection capacitor **91** for ultrasonic frequencies to the zero terminal. The transistor **77,** resistor **89** and capacitor **91** constitute a second detection circuit.

The collector of the transistor **81** is connected through a resistor **91** to the base of an npn transistor **93** the emitter of which is connected to the zero terminal **0** and the collector of which is connected through a resistor **95** to the + terminal of the supply voltage.

The collector of the transistor **93** is furthermore connected to an input of three gates **97, 99** and **101** and through a capacitor **103** to a reset input **105** of a first counter circuit **107** which also is connected through a resistor **109** to the zero terminal **0.** The capacitor **103** constitutes, together with the resistor **109,** a differentiating network.

The collector of the transistor **77** is connected to an operating signal input **111** of a first clock pulse generator **113,** an output of which is connected to an input **115** of the first counter circuit **107.**

Furthermore, the collector of the transistor 77 is connected through a capacitor **117** to the reset input of the first counter circuit **107.** This capacitor **117** likewise constitutes, together with the resistor **109,** a differentiating network.

The gating circuits **97, 99** and **101** constitute a decoder circuit and are furthermore coupled to the first counter circuit **107** and to a second clock pulse generator **119.** Their outputs are connected to two second counter circuits **121** and **123** each providing for a function adjustment of a device to be remotely controlled. Thus, for example, the counter circuit **121** may provide for a volume, contrast or luminance adjustment of a television receiver and the counter circuit **123** may provide, for example, for tuning of such a receiver.

The operation of the receiver is as follows.

Let it be assumed that a signal originating from a transmitter and having at the output of the transmitter a frequency f_1 from an instant t_0 to an instant t_1 and a frequency f_2 from the instant t_1 to the instant t_2 is received by the recorder **65** of the receiver. Apart from the time delay as a result of the finite length of the transmission path a signal of the frequency f_1 with then occur at the instant t_0 at the output of the first circuit **71** while no output voltage will occur at the output of the second circuit **73.** The transistor **81** will not conduct so that its collector voltage is high and the diode **83** is blocked. The base of the transistor **77** receives an alternating voltage through the circuit **71,** which voltage causes the collector voltage to decrease as a result of the rectifying action of the transistor **77.** At the instant t_1 when a signal of frequency f_2 is received, the transistor **81** will receive an alternating voltage so that its collector voltage decreases and the diode **83** starts to conduct when possible echoes of the frequency f_1 continue to come in after instant t_1. The transistor **77** can then no longer conduct after the instant t_1 and the voltage at the collector of the transistor **77** will therefore increase at the instant t_1. Thus a pulse whose duration T_1 is determined by the time difference between the transmission of the first and the second frequency by the transmitter is produced at the collector of the transmitter **77,** which duration T_1 is independent of echoes possibly produced between the transmitter and the receiver. This pulse is applied to the operating signal input **111** of the clock pulse generator **113** which as a result thereof applies a number of pulses to the first counter circuit **107**, which number is proportional to the duration T_1. As a result of the action of this first counter circuit **107** one of the gates **87 89, 101** is enabled dependent on the number of pulses counted.

At the instant when the first counter circuit **107** does not receive any more pulses, the gate prepared by the first counter circuit **107** of the group of gates **97, 99, 101** is enabled because the output signal of the transistor **93** is applied thereto and a clock pulse originating from the second clock pulse generator **119** is applied to the input of the counter circuits **121, 123** selected by the gating circuit until the receiver no longer receives a signal. The latter will occur shortly after the instant t_2 due to the occurrence of echoes of the frequency f_2.

The counter circuits **121, 123** provide for the adjustment of a given function, for example, volume control, tuning, luminance adjustment etc. which is generally not very critical so that a slightly inaccurate T_2 determination is unimportant. This applies all the more because the pulse distance of the pulses supplied by the second clock pulse generator is usually much longer than the said inaccuracy. The choice of the function, which is critical, is effected, as already stated, with the aid of the very accurately transmitted duration T_1.

Every time at the commencement and the end of the transmission cycle a negative going reset pulse is applied to the reset input **105** of the first counter circuit **107** via the differentiating networks **103, 109** and **117, 109** so that said counter circuit can always accurately count the number of pulses coming in per cycle. A reset pulse may of course be suppressed if desired at the end of the transmission cycle.

The second counter circuit **121** and **123** always remain in the last-occupied position so as to maintain the adjustment function value until a variation is caused by remote control.

It will be evident that the function selection and function value adjustment may be effected, if desired, in different ways than with counter circuits.

Furthermore it is possible to obtain in a simple manner an extension of the number of functions to be remotely controlled. In that case, for example, for a further group of functions the second frequency f_2 may be given a further value f'_2 in the transmitter. In the receiver an additional detection circuit for this frequency f'_2 comparable with the second detection circuit must be provided, which operates a further decoder circuit coupled to the outputs of the first counter circuit **107**, such a further decoder circuit being comparable with the decoder circuit **97, 99, 101.** A further group of counter circuits for further functions to be controlled can then be coupled to the outputs of this further decoder circuit. By further extension of the number of frequencies f_2 to be generated by the transmitter and by addition of more detection, decoding and counter circuits, the number of functions to be controlled can even be further extended.

What is claimed is:

1. A remote control system employing ultrasonic pulse duration information transmitted from a transmitter to a receiver to provide remote control of a remotely controllable device coupled to the receiver, said system comprising a transmitter with means for transmitting a first ultrasonic signal of a first frequency, means for transmitting a second ultrasonic signal of a second frequency delayed in time from the transmission of the first signal as a function of the control information to be transmitted, and said receiver includes means responsive to said first and second signals to provide a control signal containing pulse duration information determined by the time difference between the transmission of said first and second signals.

2. A remote control system as claimed in claim **1** wherein said transmitter further comprises, a generator circuit for generating ultrasonic signals of the first and of the second frequency, a frequency change-over circuit coupled to the generator circuit, a time delay circuit for determining the pulse duration information, and means for coupling said time delay circuit to the frequency change-over circuit for controlling the time at which the change of frequency from said first to said second frequency occurs.

3. A transmitter as claimed in claim **2** further comprising a number of function selection members each of which controls and corresponds to a different time delay of the time delay circuit.

4. A transmitter as claimed in claim **3** further comprising switching means coupling the generator to a source of supply voltage and including a supply switch coupled to each of the said function selection members.

5. A remote control system as claimed in claim **1** wherein the receiver includes a first signal path coupled to the input of the receiver and having a first filter tuned to the first frequency and a second signal path coupled to the input of the receiver and having a second filter tuned to the second frequency, a gating circuit included in the first signal path, a first detection circuit having an input coupled to an output of the second signal path and an output coupled to an operating signal input of the gating circuit whereby receipt of the second signal of the second frequency in the second channel actuates the gating circuit in a manner to block the passage of a signal of the first frequency through said first channel.

6. A receiver as claimed in claim **5** further comprising, a second detection circuit coupled to an output of the first signal path, a counter having a reset input and a counting pulse input, means for coupling an output of the first detection circuit to the reset input of the counter, a clock pulse generator having an output connected to the counting pulse input of the counter, and means for coupling an operating signal input of said clock pulse generator to an output of the second detection circuit.

7. A receiver as claimed in claim **6,** characterized in that the outputs of the counter are coupled to the first inputs of gating circuits which in turn are coupled to function selection circuits of the receiver, and means for coupling a second input of the gating circuits to an output of the first detection circuit.

8. A remote control system comprising, a transmitter including means for generating and transmitting, in sequence, first and second ultrasonic signals with first and second frequencies, respectively, and means for controlling the time delay between the transmission of said first and second signals as a function of a control parameter, a receiver remote from the transmitter including first and second means responsive to signals of said first and second frequencies, respectively, for deriving a control pulse the width of which is determined by the time delay between said first and second transmitted signals.

9. A remote control system as claimed in claim 8 wherein said receiver control pulse deriving means comprises, first and second filters tuned to said first and second frequencies, respectively, a gating circuit for controlling the passage of said first signal from the first filter to a utilization device, and detection means coupled to the output of the second filter and responsive to a signal of the second frequency for operating said gating circuit to block the passage of said first signal to the utilization device.

10. A remote control system as claimed in claim 8 wherein said transmitter time delay control means comprises an adjustable time delay circuit and said transmitter further comprises means controlled by the time delay circuit for changing the frequency of the signal generated by the transmitter.

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