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(54) REMOTE CONTROL SYSTEM

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a remote control system employing ultrasonic pulse duration information transmission from a transmitter to a 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 United States Patent Specification 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.

According to the invention there is provided a remote control system employing ultrasonic pulse duration information transmission from a transmitter to a receiver, in which the transmitter is adapted to transmit a first ultrasonic signal of a first frequency followed by a second ultrasonic signal of a second frequency, and in which the receiver is adapted to determine the time between the commencement of receipt of the two ultrasonic signals, said time corresponding to the pulse duration information.

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 for determining the pulse duration information, and 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 receiver and having a second filter tuned to the second frequency, the first signal path including 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 intial periods of these signals have corresponding properties at the receiver input, which properties remain corresponding when reflections occur, a well defined pulse duration is possible with a system according to the invention.

The invention will now be described with reference to a drawing.

In the drawing:

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

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

Figure 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 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 constitutes together with a capacitor 11 connected thereacross a tuned circuit which determines a 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 change-over circuit 19 is connected to the — terminal through a 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 and is directly connected to the base of an npn transistor 53 and whose cathode is connected to the — 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 at the other end to a resistor 59 connected to the base of the transistor 3.

The group 57 of parallel-arranged contacts is connected to the — 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 is conducting due to the high voltage which is present at the control electrode. The base of the transistor 53 has a low voltage, 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 reseistor 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 so that 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 is thus 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 of the relevant function selection member remaining 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 firstly 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.

Figure 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. 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 circuits with the resistor 75 and whose cathode 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 first detection circuit.

The collector of the translator 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 92 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 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 in turn 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 gates 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 and 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 provided 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 transmission path length a signal of the frequency f_1 will 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, 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 thus produced at the collector of the transistor 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 97, 99, 101 is prepared 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 that counter circuit 121 or 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 ex-

ample, 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 separation of the pulses supplied by the second clock pulse generator is usually much longer than the echo duration. The choice of the function, which is critical, is effected, as already stated, with the aid of the well defined 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 circuits 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 manners 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 more be extended.

WHAT WE CLAIM IS:—

1. A remote control system employing ultrasonic pulse duration information transmission from a transmitter to a receiver in which the transmitter is adapted to transmit a first ultrasonic signal of a first frequency followed by a second ultrasonic signal of a second frequency, and in which the receiver is adapted to determine the time between the commencement of receipt of the two ultrasonic signals, said time corresponding to the pulse duration information.

2. A transmitter for a remote control system as claimed in Claim 1, comprising a generator circuit for generating ultrasonic signals of the first and of the second frequency, 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 for determining the pulse duration information.

3. A transmitter as claimed in Claim 2, characterized in that each of a number of function selection members of the transmitter corresponds to a different time delay of the time delay circuit.

4. A transmitter as claimed in Claim 3, characterized in that a supply switch for the generator circuit is coupled to each of the said function selection members.

5. A receiver for a remote control system as claimed in Claim 1, characterized in that 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, the first signal path including a gating circuit an operating signal input of which is coupled to an output of a first detection circuit, an input of said first detection circuit being coupled to an output of the second signal path.

6. A receiver as claimed in Claim 5, characterized in that an output of the first detection circuit is furthermore coupled to a reset input of a counter a counting pulse input of which is connected to an output of a clock generator, an operating signal input of said clock pulse generator being coupled to an output of a second detection circuit coupled to an output of the first signal path.

7. A receiver as claimed in Claim 6, characterized in that the outputs of the counter are coupled to gates which are coupled to function selection circuits and an input of the gates is coupled to an output of the first detection circuit.

8. A remote control system substantially as described with reference to the accompanying drawings.

9. A transmitter for a remote control system the transmitter being substantially as described with reference to Fig. 1 of the accompanying drawings.

10. A receiver for a remote control system the receiver being substantially as described with reference to Fig. 2 of the accompanying drawings.

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3. A transmitter as claimed in Claim 2, characterized in that each of a number of function selection members of the transmitter corresponds to a different time delay of the time delay circuit.

4. A transmitter as claimed in Claim 3, characterized in that a supply switch for the generator circuit is coupled to each of the said function selection members.

5. A receiver for a remote control system as claimed in Claim 1, characterized in that 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, the first signal path including a gating circuit an operating signal input of which is coupled to an output of a first detection circuit, an input of said first detection circuit being coupled to an output of the second signal path.

6. A receiver as claimed in Claim 5, characterized in that an output of the first detection circuit is furthermore coupled to a reset input of a counter a counting pulse input of which is connected to an output of a clock generator, an operating signal input of said clock pulse generator being coupled to an output of a second detection circuit coupled to an output of the first signal path.

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