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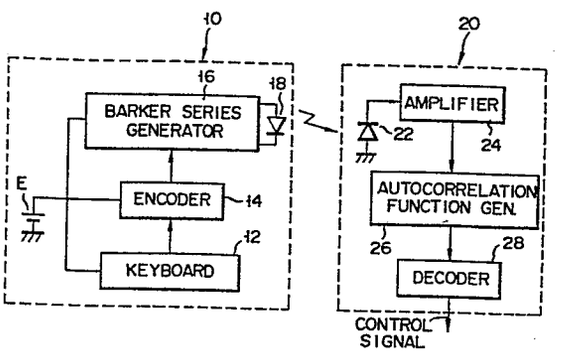
(54) **Remote control device.**

(57) A remote control device includes a transmitter (10) which is driven by a battery (E) and generates light or an ultrasonic signal, and a receiver (20) which receives the light or the ultrasonic signal for generating a corresponding control signal. The light or the ultrasonic signal produced by the transmitter (10) is modulated in accordance with Barker series data representing the control signal. The light or the ultrasonic signal received by the receiver (20) is converted into an electric signal and is supplied to an autocorrelation function generating circuit (26).

F I G. 1



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Remote control device

The present invention relates to a remote control device which is used for remote-controlling, for example, the channel selection, volume, contrast and so on of a television receiver and which uses a battery as a transmitter power source.

A conventional remote control device is known which includes a transmitter for generating an energy signal such as light or an ultrasonic wave. The energy signal is modulated on the basis of binary coded data generated in accordance with control data which is to be transmitted and a receiver which receives the energy signal transmitted from the transmitter. The receiver obtains the control data by decoding the energy signal and then supplies the decoded control data as a control signal to a controlled device such as a television receiver or the like. In order to perform correct transfer of the control data in the remote control device of this type, the following methods are adopted:

(1) Increasing an output power from the transmitter to increase an S/N ratio of the output energy signal.

(2) Successively generating output signals each corresponding to the same control data and comparing the control data each derived from a corresponding signal received at the receiver to discriminate whether

or not the control data is correct.

(3) Inserting a check bit into the control data when the control data is coverted into binary coded data to discriminate at the receiver whether or not the control data transfer is properly performed in accordance with the check bit.

However, when method (1) is adopted, the service life of the battery used as a power source for the transmitter is shortened. When method (2) is adopted, since the output energy signals, each corresponding to the single control data, are successively transmitted, the data transfer efficiency is degraded. When method (3) is adopted, a checking function and an error correction function are required for the receiver, thus complicating the construction of the receiver.

It is, therefore, an object of the present invention to provide a remote control device which can perform control data transfer with high reliability without requiring an increase of transmission output power.

According to an aspect of the present invention, a remote control device comprises transmitting means and receiving means which are arranged separately from each other. The transmitting means is driven by a battery and has code series data generating means for generating code series data which includes at least one code series whose autocorrelation function has a single sharp peak. The transmitting means also has energy signal generation means which generates an energy signal modulated in accordance with the code series data transferred from the code series data generation means. The receiving means has converting means which receives the energy signal supplied from the energy signal generation means and converts it to corresponding code series data. The receiving means also has an autocorrelation function generating circuit which receives the code series data supplied from the converting means and generates an output signal in accordance with an autocorrelation

function of the received code series data.

In the remote control device according to the present invention, the autocorrelation function of the code series included in the code series data which is supplied by the code series data generating means has a single sharp peak. Accordingly, the autocorrelation function generating circuit generates a peak pulse signal in accordance with the code series data. This enables generation of a reliable remote control signal without increasing the power of an output from the transmitting means and without being adversely affected by noise.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a remote control device according to one embodiment of this invention;

Figs. 2A and 2B show signal waveforms for illustrating the operation of a Barker series generating circuit used in the remote control device of Fig. 1;

Figs. 3A and 3B show signal waveforms for illustrating the operation of an autocorrelation function generating circuit used in the remote control device of Fig. 1;

Figs. 4A and 4B respectively show input and output signals of the autocorrelation function generating circuit shown in Fig. 1; and

Fig. 5 is a circuit diagram of a remote control device according to another embodiment of this invention.

Fig. 1 is a block diagram showing a remote control device used for controlling, for example, the channel selection, volume, contrast and so on of a television receiver, according to an embodiment of the present invention. The remote control device includes a transmitter 10 which is driven by a battery E for generating a light signal and a receiver 20 which generates a control signal in correspondence with the light signal

from the transmitter 10.

The transmitter 10 includes a keyboard 12 having channel selecton keys, a volume control switch, a contrast control switch and so on; an encoder 14 for converting a control signal from the keyboard 12 into, e.g., 8-bit binary code; a Barker series generating circuit 16 for generating a Barker series whose autocorrelation function has a single sharp peak in correspondence with a "1" bit having a high level included in the binary code supplied from the encoder 14; and a light-emitting diode 18 for generating a light signal which is modulated in accordance with the Barker series supplied from the Barker series generating circuit 16.

The receiver 20 includes a photodiode 22 for converting a light signal from the light-emitting diode 18 into an electric signal; an amplifier circuit 24 for amplifying and wave-shaping the electric signal obtained by the photodiode 22; an autocorrelation function generating circuit 26 formed of, for example, a charge coupled device for calculating the autocorrelation function of an output signal supplied from the amplifier circuit 24; and a decoder 28 for decoding an autocorrelation function signal supplied from the autocorrelation function generating circuit 26 and for supplying the same as a control signal to a television receiver (not shown).

A circuit which generates a 2-, 3-, 4-, 5-, 7-, 11- or 13-bit Barker series in response to a single pulse can be used as the Barker series generating circuit 16. In an embodiment of the present invention, a circuit which generates a 13-bit Barker series is adopted. In other words, the Barker series generating circuit 16 generates a Barker series having 13 bits of "1", "1", "1", "1", "1", "0", "0", "1", "1", "0", "1", "0" and "1" in accordance with, for example, "1"-bit data having a logic level "1" supplied from the encoder 14.

Assume that when the encoder 14 generates data (1,0,1,0) as a part of an output binary code, as shown in Fig. 2A, the Barker series generating circuit 16 generates a Barker series every time the output bit from the encoder 14 is set to logic level "1", as shown in Fig. 2B. The duration corresponding to each bit in the Barker series is T and the duration corresponding to the entire length of each Barker series is 13T.

The autocorrelation function generating circuit 26 generates an autocorrelation function $\phi(t)$ of the input signal X(t) calculated according to the following equation:

$$\phi(t) = \sum_{k=1}^{13} X(-kT) \cdot X(t-kT)$$

Note that X(t) represents a Barker series in the present embodiment and is given by;

$$X(t) = [1,1,1,1,1,0,0,1,1,0,1,0,1]$$

Thus, the autocorrelation function generating circuit 26 generates the autocorrelation function $\phi(t)$ shown in Fig. 3B upon receiving the Barker series X(t) shown in Fig. 3A.

The mode of operation of the remote control device shown in Fig. 1 will now be described.

First, the keyboard 12 is operated to generate a control signal for performing desired control at the television receiver. The encoder 14 converts the control signal into corresponding binary coded data. The Barker series generating circuit 16 generates a Barker series in response to each "1"-bit signal at high level included in the binary coded data supplied from the encoder 14, in a manner explained with reference to Figs. 2A and 2B. As a result, the light-emitting diode 18 is intermittently biased according to the Barker series supplied from the Barker series generating circuit 16 and generates light which is modulated in accordance with the Barker series. Upon receiving the light supplied from the light-emitting diode 18,

the photodiode 22 causes a current corresponding to the intensity of the light to be supplied to the amplifier 24. Therefore, the amplifier 24 generates Barker series data corresponding to the Barker series data supplied from the Barker series generating circuit 16, that is, the Barker series data shown in Fig. 2B. The generated Barker series data is supplied to the autocorrelation function generating circuit 26. In a manner explained with reference to Figs. 3A and 3B, the autocorrelation function generating circuit 26 generates an autocorrelation function having a single sharp peak as shown in Fig. 3B every time it receives a Barker series. The decoder 28 detects a peak pulse component or components included in an output signal from the autocorrelation function generating circuit 26 and supplies a corresponding control signal to the television receiver (not shown).

As mentioned above, in the remote control device shown in Fig. 1, the output power from the transmitter 10 can be decreased provided the light signal is transmitted from the light-emitting diode 18 to the photodiode 22 and then the autocorrelation function generating circuit 26 generates an output signal including at least one peak pulse component which can be separated and detected as a logic signal of "1". Furthermore, even if the S/N ratio of the light signal transmitted from the transmitter 18 is 0dB or lower, a peak pulse component having a level high enough to be detected by the decoder 28 can be generated by the autocorrelation function generating circuit 26. For example, in an experiment wherein an input signal whose S/N ratio was -11dB, as shown in Fig. 4A, was supplied to the autocorrelation function generating circuit 26, an autocorrelation function signal including a peak pulse component which could be separated and detected, as shown in Fig. 4B, was produced.

Although the present invention has been described

above with reference to a particular embodiment, it is to be understood that the present invention is not limited to this embodiment. For example, in the embodiment shown in Fig. 1, the light-emitting diode 18 and the photodiode 22 are used for transmitting the light signal from the transmitter 10 to the receiver 20. However, another type of energy signal can be substituted for the light signal. A remote control device using an ultrasonic signal shown in Fig. 5 is similar to that shown in Fig. 1 except that the device in Fig. 5 uses electroacoustic transducers 19 and 23 each formed of a piezoelectric element in place of the light-emitting diode 18 and the photodiode 22. In the remote control device of this type, an ultrasonic signal is produced by the transducer 19 and then transmitted to the transducer 23, where it is converted into an electric signal.

Furthermore, in the remote control device shown in Fig. 1, another circuit which generates another type of coded series, such as a Hadamard series, can be used instead of the Barker series generating circuit 16.

In addition, in the above description, the Barker series generating circuit 16 generates the Barker series in accordance with "1"-bit signals at a logic "1" level supplied from the encoder 14. However, the configuration of the device can be changed such that the Barker series generating circuit 16 generates the Barker series in accordance with "0"-bit signals supplied from the encoder 14.

Claims:

1. A remote control device comprising transmitting means (10), using a battery (E) as a drive power source, for emitting an energy signal in accordance with a control signal and receiving means (20), disposed separately from said transmitting means (10), for receiving the energy signal from said transmitting means (10) and deriving the control signal on the basis of a received energy signal, characterized in that said transmitting means (10) includes code data generation means (12, 14, 16) for generating code series data including at least one code series whose autocorrelation function has a single sharp peak, and energy signal generation means (18; 19) for generating the energy signal modulated in accordance with the code series data from said code series data generation means (12, 14, 16); and said receiving means (20) includes converting means (22, 24; 23, 24) for receiving and converting the energy signal from said energy signal generation means (18; 19) into corresponding code series data, autocorrelation function generation means (26) for generating an output signal corresponding to the autocorrelation function of the code series data supplied from said converting means (22, 24; 23, 24), and control signal generating means (28) for generating a control signal corresponding to the output signal from said autocorrelation function generation means (26).

2. A remote control device according to claim 1, characterized in that said code data generation means (12, 14, 16) comprises keyboard means (12) for generating a control signal in response to a key operation, coding means (14) for converting the control signal supplied from said keyboard means (12) into binary coded data, and a code series generating circuit (16) which generates the code series data in accordance with the binary coded data supplied from said coding means (14).

3. A remote control device according to claim 2, characterized in that said code series generating circuit (16) comprises a Barker series generating circuit.

4. A remote control device according to claim 3, characterized in that said energy signal generation means comprises a light-emitting diode (18) and said converting means comprises a photodiode (22).

5. A remote control device according to claim 4, characterized in that said control signal generation means (28) comprises a decoder.

6. A remote control device according to claim 3, characterized in that said energy signal generation means comprises an electroacoustic transducer (19) and said converting means comprises an electroacoustic transducer (23).

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FIG. 1

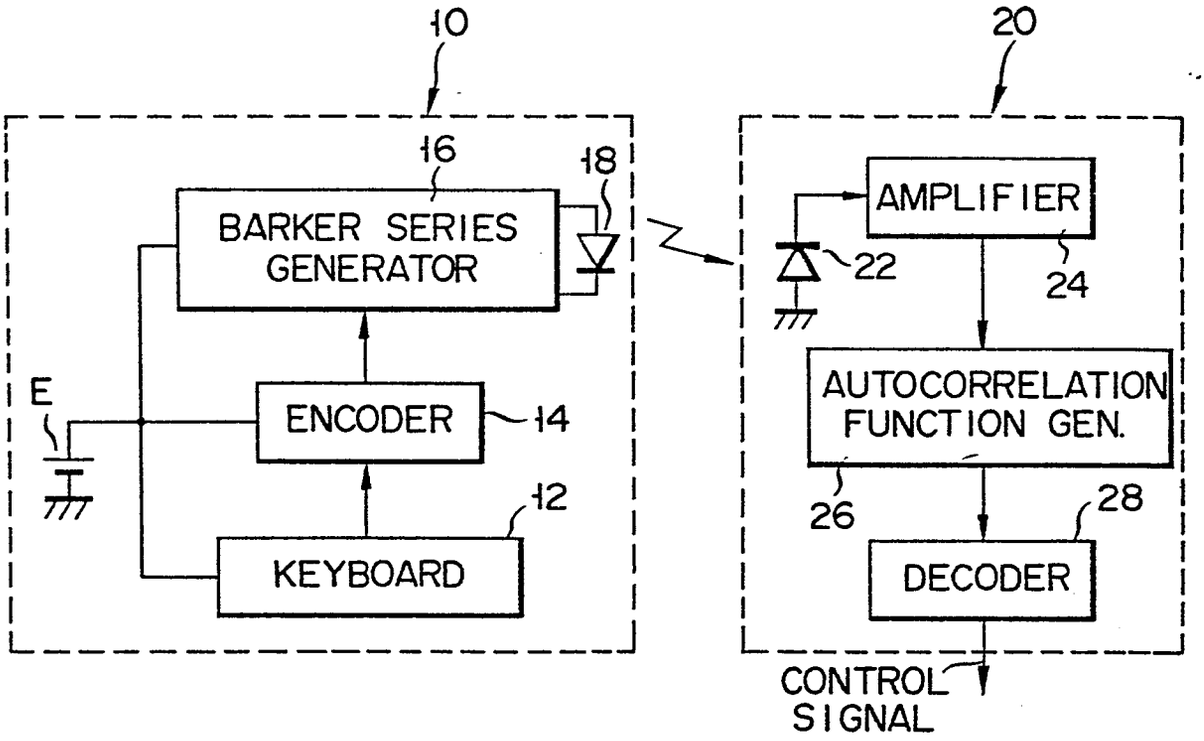
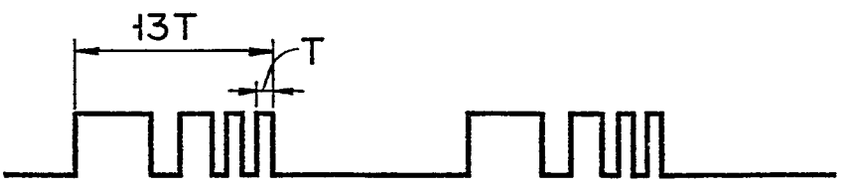


FIG. 2A

FIG. 2B



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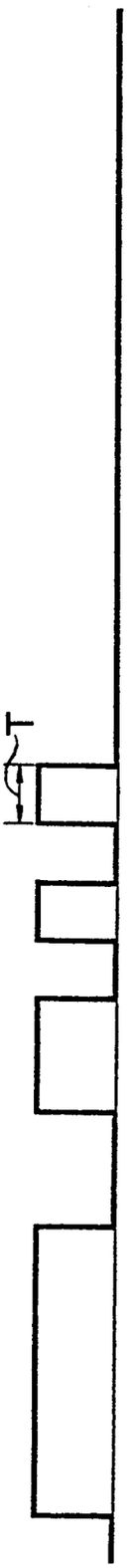

FIG. 3A

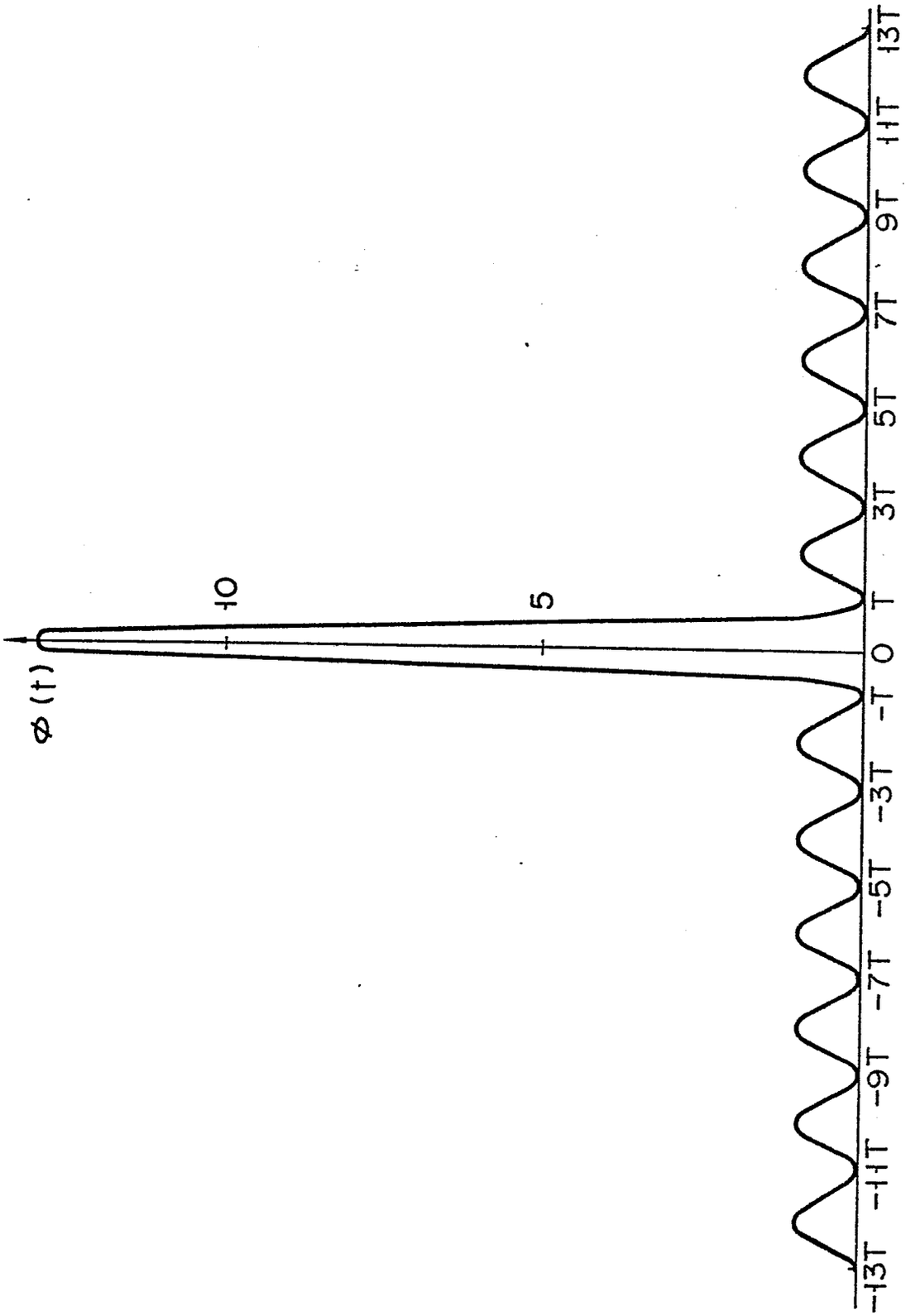

FIG. 3B

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FIG. 4A

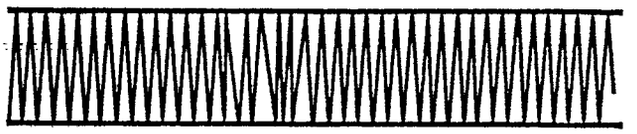

FIG. 4B

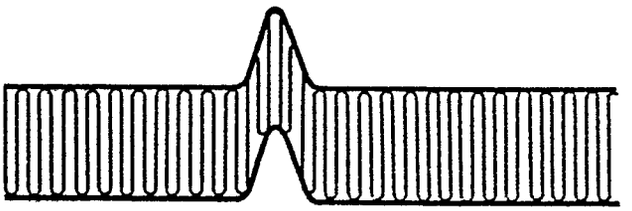

FIG. 5