

REMOTE CONTROL DEVICE

The present invention relates to remote control devices and is concerned particularly although not exclusively with such a device for remotely controlling by radio a mobile monitoring or cleaning robot.

As shown in Figure 6 of the accompanying diagrammatic drawings, U.S. laid open Patent Application No. 4,549,179 discloses a conventional remote control transmitting device for a robot, having an integrated circuit-equipped encoder 70, and in order to operate the robot, a user presses one of a predetermined number of buttons mounted on a remote control transmitting device.

The predetermined number of buttons consist of secret-coded buttons and function-coded buttons, and when the user wants to use the remote-control transmitting device, he or she should first press his or her own secret-coded buttons and then press the function-coded buttons corresponding to an operation of the robot, thereby to move the robot.

However, the conventional remote control transmitting device consists of only one switch SW 61 for a button which can input function codes, resulting in an inconvenience of providing separate remote control transmitting devices for each operation when the robot is operated for various different purposes.

Accordingly, the cost for remote control transmitting devices necessary for operation of the robot has been naturally increased and many inconveniences involving the various operations of the robot have followed.

In Figure 6, reference numeral B 61 denotes a battery, R 61 - R 66 are resistors, Q 61 and Q 62 are transistors, C 61 and C 62 are capacitors and D 61 - D 63 are infrared light emitting diodes.

5 The present invention arose from a consideration of the various
aforementioned drawbacks, and it is an aim of preferred embodiments of the
present invention to provide a remote control transmitting device for a robot
by which the robot can be easily operated, manufacturing cost can be lowered
and operational functions of the robot can be diversified.

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According to an aspect of the invention, there is provided a remote
control transmitting device for a robot, the device comprising:

a battery or other power supply for outputting a direct voltage;

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secret number switching means for inputting a user's secret number;

a function selecting switch for a user to select one function among alert
functions and movement functions;

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a high level & open signal transmitting circuit wherein, when the
function selecting switch is rendered conductive, a voltage of high level output
from the battery or other power supply is received, thereby to output a voltage
of high level indicative of movement functions, and when the function
25 selecting switch is turned off, an open signal is generated indicative of alert
functions;

operation command switching means into which operation commands denoting, for example, release, warning sound, scouting, left, forward and right functions are received from the user;

5 a low- & enable signal transmitting circuit for outputting a low signal and an enable signal after receipt of a user's operation command signal output from the operation command switching means;

10 an encoder wherein, when a given operation command is received from the user, a secret-coded signal output from the secret number switching means and user's function and operation command signals output from the high level & open signal transmitting circuit and the low & enable signal transmitting circuit are received, thereby to output in pulses the secret-coded signals and function & operation command signals;

15 a pulse width control circuit for controlling a pulse width output from the encoder; and

20 an output transmitting circuit wherein, following receipt of pulses manipulated by the pulse width control circuit and output by the encoder, the pulses are modulated to a very high frequency and output as infrared signals towards the robot.

25 The secret number switching means preferably comprises seven switches, movable contacts of which are commonly connected to an enable terminal of the encoder, and stationary contacts of which are respectively connected to input terminals of the encoder.

The high level & open signal transmitting circuit may comprise a first resistor and diode connected in series, and a second resistor and diode connected in series, wherein one end of the resistors are commonly connected thereafter to a movable contact of the function selecting switch; one end of the first diode is commonly connected to a second input terminal of the encoder and a stationary contact of a second switch of the operation command switching means; and one end of the second diode is commonly connected to a first input terminal of the encoder and a stationary contact of a first switch of the operation command switching means.

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The operation command switching means may comprise the first switch, the second switch and a third switch; a movable contact of the first switch, a movable contact of the second switch and a movable contact of the third switch being commonly connected to a negative (-) terminal of the battery or other power supply; the stationary contact of the first switch being commonly connected to a cathode of the second diode in the high level & open signal transmitting circuit and the first input terminal of the encoder; the stationary contact of the second switch being commonly connected to a cathode of the first diode in the high level & open signal transmitting circuit and the second input terminal of the encoder; and a stationary contact of the third switch being connected to a cathode of a diode of the low & enable signal transmitting circuit.

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The low & enable signal transmitting circuit preferably comprises three diodes, the anodes of which are commonly connected to a terminal of a ground potential side of the output transmitting circuit and an enable terminal of the encoder, while a cathode of one of the three diodes is connected to the stationary contact of the third switch in the operation command switching

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means, a cathode of another of the three diodes is connected to the stationary contact of the second switch in the operation command switching means, and a cathode of the other of the three diodes is connected to the stationary contact of the first switch in the operation command switching means.

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An earth terminal of the encoder is preferably commonly connected to an enable terminal of the encoder.

The invention extends to a remotely controlled robot provided with, and adapted to receive control signals from, a remote control transmitting device in accordance with the invention.

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For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

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Figure 1 is a block diagram of an embodiment of a remote control transmitting device of a robot in accordance with the present invention;

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Figure 2 is a detailed circuit drawing of Figure 1;

Figure 3A is a drawing of a signal waveform corresponding to a secret-code number when the secret-coded number is given as in the embodiment of Figures 1 and 2;

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Figure 3B is a drawing of a signal waveform output from an encoder during a release function:

Figure 3C is a drawing of a signal waveform output from the encoder during a warning sound function;

5 Figure 3D is a drawing of a signal waveform output from the encoder during a scouting function:

Figure 3E is a drawing of a signal waveform output from the encoder when the robot moves to the left :

10 Figure 3F is a drawing of a signal waveform output from the encoder when the robot moves forwardly;

Figure 3G is a drawing of a signal waveform output from the encoder when the robot moves to the right:

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Figure 4A is a drawing of an output signal of the encoder when an open signal is received into one of a plurality of input terminals (A1-A7, DT1, DT2) of the encoder;

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Figure 4B is a drawing of the output signal of the encoder when a signal of high level is received into one of the input terminals (A1-A7, DT1, DT2) of the encoder;

25 Figure 4C is a drawing of the output signal of the encoder when a signal of low level is received into one of the input terminals (A1-A7, DT1, DT2) of the encoder;

Figure 5 is a table for showing a correlation between an on-off state of a function selecting switch SW1 illustrated in Figure 1, three switches SW2, SW3 and SW4 of an operation command switching means and six kinds of operation commands; and

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Figure 6 shows the above-mentioned conventional remote control transmitting device for a robot.

In Figure 1 and Figure 2, reference BAT is a battery for outputting a direct current voltage, SW5 is a secret number switching means, and SW1 is a function selecting switch for selecting one function out of alert functions and movement functions.

Reference numeral 4 is a high level & open signal transmitting circuit wherein, when the function selecting switch SW1 is rendered conductive, a voltage of high level output from the battery BAT is received, whereby the voltage of high level is recognized as a signal of high level by the encoder 1 (to be explained later) thereby to output a voltage indicative of the movement function, and when the function selecting switch SW1 is turned off, signals input into input terminals DT1 and DT2 are recognized as open signals by the encoder 1 (to be explained later) thereby to generate a voltage indicative of the function.

Likewise, reference numeral 6 is an operation command switching means into which operation commands such as release, warning sound, scouting, left, forward and right are input from the user, a reference numeral 8 is a low & enable signal transmitting circuit for outputting a low signal and

an enable signal after receipt of the user's operation command signal output from the operation command switching means.

5 In the encoder 1, when the operation commands indicative of release, warning sound, scouting, left and right are received from the user, the secret-coded signal output from the secret number switching means and the user's function and operation command signals output from the high level & open signal transmitting circuit and the low & enable signal transmitting circuit are received, thereby to output in pulses the secret-coded signal and function &
10 operation command signals, and in this case the encoder 1 comprises Motorola MC145626 integrated circuits.

Furthermore, reference numeral 10 is a pulse width control circuit for controlling a pulse width output from the encoder 1 and reference numeral 12
15 is an output transmitting circuit wherein, after receipt of pulses output from the encoder which control pulse widths output from the encoder, the pulses are modulated to a very high frequency thereafter to be output as infrared signals toward the robot.

20 The secret number switching means SW5 is composed of seven switches S1-S7, movable contacts S1a-S7a of which are commonly connected to an enable terminal $\overline{TE}$ of the encoder, and stationary contacts S1b-S7b of which are respectively connected to input terminals A1-A7 of the encoder 1.

25 The high level & open signal transmitting circuit 4 comprises the resistors R1 and R2 and diodes D1 and D2, in which the resistor R1 and diode D1 are connected in series, and the resistor R2 and diode D2 are connected in series.

The ends of the resistors R1 and R2 which are not connected with the diodes D1 and D2 are commonly connected to a movable contact SW1a of the function selecting switch SW1.

- 5 The end of the diode D1 not connected to the resistor R1 is commonly connected to the input terminal DT1 of the encoder 1 and a stationary contact SW2b of a first switch SW2 in the operation command switching means 6.

- 10 The operation command switching means 6 comprises first switch SW2, second switch SW3 and third switch SW4, and a movable contact SW2a of the first switch SW2, a movable contact SW3a of the second switch SW3 and a movable contact SW4a of the third switch SW4 are commonly connected to a negative (-) terminal of the battery BAT.

- 15 A stationary contact SW2b of the first switch SW2 is commonly connected to a cathode of the diode D2 in the high level & open signal transmitting circuit 4 and the input terminal DT1 of the encoder.

- 20 A stationary contact SW3b of the second switch SW3 is commonly connected to a cathode of the diode D1 in the high level & open signal transmitting circuit 4 and the input terminal DT2 of the encoder 1.

- 25 A stationary contact SW4b of the third switch SW4 is connected to a cathode of the diode D3 in the low & enable signal transmitting circuit 8.

Meanwhile, the low & enable signal transmitting circuit 8 comprises three diodes D3, D4 and D5, the anodes of which are commonly connected

to a terminal of ground potential side of the output transmitting circuit and an enable terminal $\overline{TE}$ of the encoder 1.

5 The cathode of the diode D3 is connected to a stationary contact SW4b of the third switch SW4 in the operation command switching means 6.

A cathode of the diode D4 is connected to the stationary contact SW3b of the second switch SW3 in the operation command switching means 6, and a cathode of the diode D5 is connected to the stationary contact SW2b of the
10 first switch SW2 in the operation command switching means 6.

An earth terminal VSS of the encoder 1 is commonly connected to the enable terminal $\overline{TE}$ of the encoder 1.

15 The pulse width control circuit 10 comprises a resistor R5, a capacitor C4 and a resistor R6. One end each of the resistor R5, capacitor C4 and resistor R6 are interconnected and the other end of the resistor R5 is connected to an input terminal RTC of the encoder 1, the other end of the capacitor C4 is connected to an input terminal CTC of the encoder 1 and the
20 other end of the resistor R6 is connected to an input terminal RS of the encoder 1.

The output transmitting circuit 12 comprises a resonator REI, infrared light emitting diode LED 1, a pattern antenna L1 printed on a printed circuit
25 board, a transistor TR1, capacitors C1, C2 and C3, and resistors R3, R4 and R7.

One end of the resonator RE1 is connected through the resistor R3 to an output terminal OUT of the encoder 1 and at the same time to the transistor TR1 at its base.

5 An emitter of the transistor TR1 is commonly connected to the resistor R4 and the capacitor C2, and thereafter connected to a collector of the transistor TR1 through the capacitor C1.

10 The collector of the transistor TR1 is connected through one end of the capacitor C3 to the pattern antenna L1 and at the same time, to a balance terminal of the capacitor C3 through the pattern antenna L1, and to a cathode of the light emitting diode LED 1 through a resistor R7 simultaneously.

15 Now, an overall operating example of the illustrated embodiment of the remote control transmitting device for a robot in accordance with the present invention will be described.

20 First of all, the user inputs a secret number (for instance 1010111) to the secret number switching means SW5.

 At this moment, switches S2 and S4 out of the secret number switching means SW5 of dip switch configuration are rendered operative and balance switches S1, S3, S5, S6 and S7 are in turn rendered inoperative.

25 Next, the user should determine in which function the robot will operate, as between functions and movement functions.

If the user determines to operate the robot in a warning function, the function selecting switch SW1 having a slide switch configuration is rendered inoperative.

- 5 Next, if the user wants to operate the robot in a scouting function during alert functions, the third switch SW4 out of switches SW2, SW3 and SW4 having a push button switch configuration is pressed.

10 If the third switch SW4 is rendered operative, a current flows through a closed circuit which is formed by a positive (+) terminal of battery BAT → a current terminal VDD of the encoder 1 → ground terminal of the encoder 1 → diode D3 → stationary contact SW4b of the third switch SW4 movable contact SW4a of the third switch SW4 → negative (-) terminal of battery, and at the same time, a current flows through a closed circuit which is formed by
15 a positive (+) terminal of battery BAT → anode of light emitting diode LED 1 → cathode of light emitting diode LED 1 → resistor R7 → capacitor C3 → diode D3 → stationary contact SW4b of the third switch SW4 → movable contact SW4a of the third switch SW4 → negative (-) terminal of battery BAT.

20 Accordingly, a power source is supplied to the encoder 1 thereby to render the encoder 1 operative, and an open signal is supplied to input terminal A1 of the encoder 1 because the switch S1 is rendered inoperative.

25 A signal of low level is supplied to the other input terminal A2 because the switch S2 is rendered conductive.

Subsequently, an open signal is supplied to input terminal A3, a signal of low level is supplied to input terminal A4. an open signal is supplied to

input terminal A5, an open signal is supplied to input terminal A6 and an open signal is supplied to input terminal A7.

5 Likewise, an open signal is supplied to input terminal DT1 of the encoder 1 because the switch SW2 is in an open state, and an open signal is supplied to input terminal DT2 because the switch SW3 is in a open state.

10 Furthermore, a potential of low level is supplied to the enable terminal $\overline{TE}$ of the encoder 1 by interposing the movable contact SW4a, stationary contact SW4b and diode D3 of the third switch SW4, thereby to output from the output terminal OUT of the encoder 1 an item (secret number 1010111) input into the input terminals A1-A7 and an item (open, off: scouting command) input into the other input terminals DT1 and DT2.

15 At this moment, out of the output terminal OUT of the encoder 1 come sequentially waveforms as illustrated in Figure 3A and in the rear portion of Figure 3D.

20 Next, when the waveforms are output, the resonator RE1 oscillates at approximately 300 MHZ thereby to modulate the waveforms of Figure 3D to approximately, 300 MHz, and the transistor TR1 amplifies the modulated waveforms whereby an infrared signal is output from the light emitting diode LED 1.

25 Next, an infrared receiving unit of the robot system receives the infrared signal thereby to make the robot perform a scouting function.

When the user wants the robot to generate a warning sound during the scouting function of the robot, the second switch SW3 of the operation command switching means 6 is pressed under a state that the function selecting switch SW1 is rendered inoperative.

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When the second switch SW3 is rendered operative, a closed circuit is formed through the diode D4 thereby to supply a signal of low level to the enable terminal TE and input terminal DT2 of the encoder 1, and the open signal is still supplied to the input terminal DT1, and then a signal is supplied to input terminals A1-A7 of secret numbers in the same manner as the
10 aforementioned scouting function.

At this moment a waveform as illustrated in Figure 3A and a waveform as illustrated in the rear portion of Figure 3C are sequentially output from the
15 output terminal OUT of the encoder 1.

And next, an infrared signal is output from the infrared light emitting diode LED1 by the aforementioned operation thereafter to make the robot generate a warning sound.

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Next, when the user wants the robot released either from the alert functions or scouting function, the user presses the first switch SW2 of the operation command switching means 6 under a state that the function selecting switch SW1 is kept inoperative.

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When the first switch SW2 is rendered conductive, a closed circuit is formed through the diode D5, thereby to make a signal of low level supplied

to the enable terminal $\overline{TE}$ and input terminal DT1 of the encoder 1 and thereby to make an open signal supplied to the input terminal DT2.

Furthermore, the same signal of the secret-coded number as when in
5 scouting function is applied to the input terminals A1-A7.

At this moment, the waveform as illustrated in Figure 3A and the waveform as illustrated in the rear portion of Figure 3B are sequentially output from the output terminal OUT of the encoder 1, thereby to make the
10 infrared signal output by the aforementioned operation from the infrared light emitting diode LED 1, and thereafter to make the robot perform a releasing function.

If the user wants the robot to operate in a movement operation among
15 the alert and movement functions, the user fixes the function selecting switch SW1 to an "ON" position.

Next, when the user wants the robot to move forwardly among the movement functions, the user presses the second switch SW3 of the operation
20 command switching means 6.

When the second switch SW3 is rendered conductive, a current flows through the diode D4 in a closed circuit which is formed by the positive (+) terminal of battery BAT → stationary contact SW1b of function selecting switch SW1 → movable contact SW1a of function selecting switch SW1 → resistor R1 → anode of the diode D1 → cathode of the diode D1 → movable contact SW3a of the second switch SW3 → negative (-) terminal of battery
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BAT, thereby to supply a signal of low level to the input terminal DT2 of the encoder 1.

Furthermore, a current flows through a current loop which is formed by the positive (+) terminal of battery BAT → stationary contact SW1b of function selecting switch SW1 → movable contact SW1a of function selecting switch SW1 → resistor R2 → diode D2 → input terminal DT1 of the encoder 1, thereby to supply a voltage of high level to the input terminal DT1 of the encoder 1.

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Accordingly, at this moment, a waveform as illustrated in Figure 3A and a waveform as illustrated in the rear portion of Figure 3F are sequentially output from the output terminal OUT of the encoder 1 thereby to move the robot forwardly.

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When the user wants the robot to move to the left among the movement functions, the user presses the first switch SW2 of the operation command switching means 6.

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At this moment a signal of low level is supplied to the input terminal DT1 of the encoder 1, a signal of high level to the input terminal DT2, and a signal of low level is supplied to the enable terminal TE, so that a waveform as illustrated in Figure 3A and a waveform as illustrated in the rear portion of Figure 3E are output from the output terminal OUT of the encoder 1, thereby to move the robot to the left.

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Meanwhile, when the user wants the robot to move to the right among the movement functions, the user presses the third switch SW4 under a state

that the function selecting switch SW1 is kept conductive. At this moment, a signal of high level is respectively supplied to the input terminals DT1 and DT2 of the encoder 1, and a signal of low level is supplied to the enable terminal $\overline{TE}$ and a signal of secret-coded numbers input during the scouting
5 operation of the alert functions is equally input to the input terminals A1-A7 of the aforementioned secret numbers.

Next, a waveform as illustrated in Figure 3A and a waveform as illustrated in the rear portion of Figure 3G are sequentially output from the
10 output terminal of the encoder 1, thereby to make the robot move to the right through the aforementioned operations.

Next, when the user wants the robot to stop to take a rest, the user transmits a stop & rest command to the robot by pressing a button (not
15 shown). Then the robot is stopped to rest.

Meanwhile, when the user by mistake presses more than two switches out of the first, second and third switches SW2, SW3 and SW4 simultaneously, the encoder 1 designates a priority, thereby to output only one
20 operating signal out of the three operating signals of the alert functions or outputs only one operating signal out of the three operating signals of the movement functions.

The priority is determined by the user when the operation command
25 switching means is assembled to the encoder 1.

As seen in the foregoing, according to the illustrated example of the remote control transmitting device of a robot in accordance with the present

invention, a 4-switch combination to the conventional encoder enables the output of six different operating command signals, so that the robot can be easily operated, the manufacturing cost of the product can be reduced, and operating functions can be diversified.

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Furthermore, a carrying of the robot becomes easy because the remote control transmitting device may be light and the circuit is simple, thereby to make it easy to be manufactured.

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The term "ground potential" (or like terms such as "ground voltage" or "earth" potential or voltage) is used conveniently in this specification to denote a reference potential. As will be understood by those skilled in the art, although such reference potential may typically be zero potential, it is not essential that it is so, and may be a reference potential other than zero.

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CLAIMS:

1. A remote control transmitting device for a robot, the device comprising:

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a battery or other power supply for outputting a direct voltage;

secret number switching means for inputting a user's secret number;

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a function selecting switch for a user to select one function among alert functions and movement functions;

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a high level & open signal transmitting circuit wherein, when the function selecting switch is rendered conductive, a voltage of high level output from the battery or other power supply is received, thereby to output a voltage of high level indicative of movement functions, and when the function selecting switch is turned off, an open signal is generated indicative of alert functions;

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operation command switching means into which operation commands denoting, for example, release, warning sound, scouting, left, forward and right functions are received from the user;

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a low & enable signal transmitting circuit for outputting a low signal and an enable signal after receipt of a user's operation command signal output from the operation command switching means;



an encoder wherein, when a given operation command is received from the user, a secret-coded signal output from the secret number switching means and user's function and operation command signals output from the high level & open signal transmitting circuit and the low & enable signal transmitting circuit are received, thereby to output in pulses the secret-coded signals and function & operation command signals:

a pulse width control circuit for controlling a pulse width output from the encoder; and

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an output transmitting circuit wherein, following receipt of pulses manipulated by the pulse width control circuit and output by the encoder, the pulses are modulated to a very high frequency and output as infrared signals towards the robot.

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2. A remote control transmitting device according to claim 1, wherein the secret number switching means comprises seven switches, movable contacts of which are commonly connected to an enable terminal of the encoder, and stationary contacts of which are respectively connected to input terminals of the encoder.

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3. A remote control transmitting device according to claim 1 or 2, wherein the high level & open signal transmitting circuit comprises a first resistor and diode connected in series, and a second resistor and diode connected in series, wherein one end of the resistors are commonly connected thereafter to a movable contact of the function selecting switch; one end of the first diode is commonly connected to a second input terminal of the encoder and a stationary contact of a second switch of the operation command

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switching means; and one end of the second diode is commonly connected to a first input terminal of the encoder and a stationary contact of a first switch of the operation command switching means.

5 4. A remote control transmitting device according to claim 3, wherein the operation command switching means comprises the first switch, the second switch and a third switch; a movable contact of the first switch, a movable contact of the second switch and a movable contact of the third switch being commonly connected to a negative (-) terminal of the battery or other power supply; the stationary contact of the first switch being commonly connected to a cathode of the second diode in the high level & open signal transmitting circuit and the first input terminal of the encoder; the stationary contact of the second switch being commonly connected to a cathode of the first diode in the high level & open signal transmitting circuit and the second input terminal of the encoder; and a stationary contact of the third switch being connected to a cathode of a diode of the low & enable signal transmitting circuit.

20 5. A remote control transmitting device according to claim 4, wherein the low & enable signal transmitting circuit comprises three diodes, the anodes of which are commonly connected to a terminal of ground potential side of the output transmitting circuit and an enable terminal of the encoder, while a cathode of one of the three diodes is connected to the stationary contact of the third switch in the operation command switching means, a cathode of another of the three diodes is connected to the stationary contact of the second switch in the operation command switching means, and a cathode of the other of the three diodes is connected to the stationary contact of the first switch in the operation command switching means.



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6. . A remote control transmitting device according to any of the preceding claims, wherein an earth terminal of the encoder is commonly connected to an enable terminal of the encoder.

5 7. A remote control transmitting device substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

8. A remote control transmitting device substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

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9. A remotely controlled robot provided with, and adapted to receive control signals from, a remote control transmitting device according to any of the preceding claims.