

Aug. 3, 1965

W. E. BAIER, JR
SONIC CONTROL CIRCUITRY

3,199,070

Filed Jan. 14, 1963

2 Sheets-Sheet 1

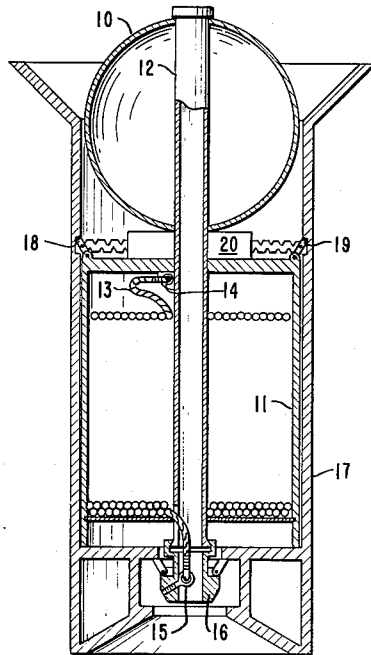


FIG. 1

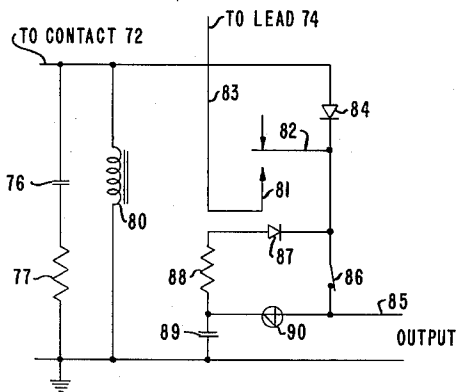


FIG. 3

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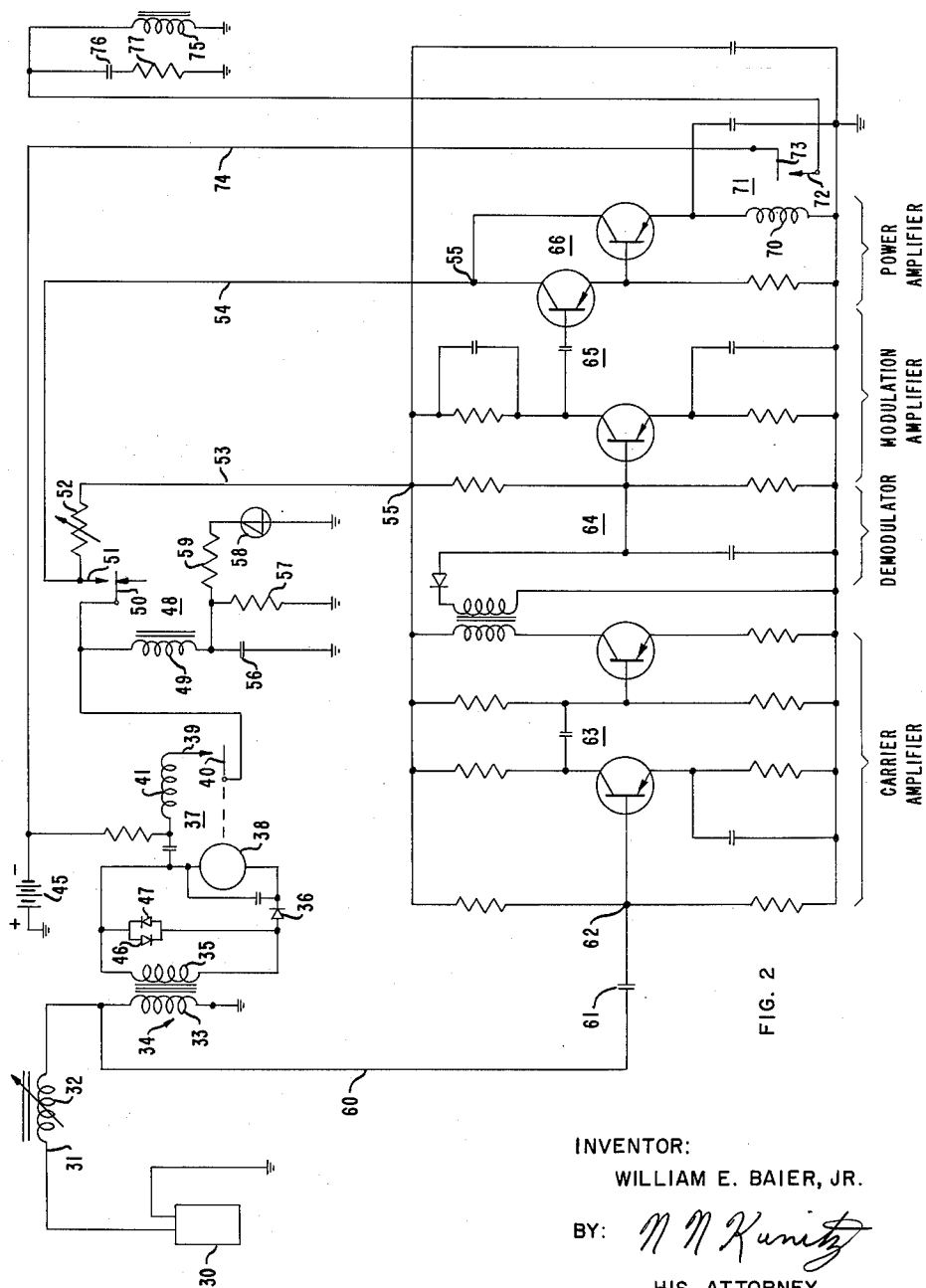
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SONIC CONTROL CIRCUITRY

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18 Claims. (Cl. 340-5)

This invention relates to a system for selectively controlling a desired operation at a remote and inaccessible location which system is responsive to propagated wave energy. More particularly, the invention relates to a control system, located at an inaccessible location, which is maintained in an unenergized condition until activated by a coded signal. The apparatus of this invention has particular use in underwater well installations wherein some control function must be performed on equipment located on the ocean floor. The apparatus of this invention can be used to release an underwater buoy which has been secured to an underwater well installation to mark its location. Such a buoy is shown in U.S. Patent No. 3,066,325, issued Dec. 4, 1962 to William J. Hayes.

One of the major problems in the use of control equipment at an inaccessible location which is responsive to coded propagating wave energy has been the necessity of providing power to the receiver so that it will always be in a condition to receive an incoming signal. The power necessary to maintain a receiver in even a stand-by condition will, due to continuous use of power, drain the storage batteries used for the power supply in a relatively short period of time. When it is required that the inaccessible location control system be capable of operating for long periods of time, e.g., a number of years, this constant drain of the power supply makes this type of control system economically unfeasible.

To overcome this objection to propagated wave remote control systems a number of methods of conserving power have been proposed in the past. These systems, however, usually require separate circuitry which is responsive to a special call signal for connecting the power to the receiver which can then receive the transmitted control signal. Such systems require that at least two signals of different frequency be transmitted in the correct sequence and the receiver be responsive to two separate frequencies, resulting in a relatively overall complexity. Furthermore, these systems, unless they use a complex call signal, e.g., a plurality of pulses, cannot reject spurious noise which may be of the proper call signal frequency. Such a spurious noise may, if it is prolonged, cause the receiver to remain in an operative condition and thus defeat the power-conserving feature of the receiver.

It is therefore a general object of this invention to provide an improved circuit which in effect is maintained in unenergized condition until actuated by a coded control signal.

It is another object of this invention to provide a remote control system which is responsive to a coded control signal and in effect is maintained in an inoperative condition until the particular control signal is received.

It is a further object of this invention to provide a remote control system which is maintained in an inoperative condition until a signal having a preselected frequency is received and which is promptly deactivated after being partially activated by spurious signals of the preselected frequency.

A still further object of this invention is to provide a release mechanism for an underwater buoy which is responsive to a particularly coded signal and in effect is maintained in an inoperative condition until the particularly coded signal is received.

Briefly, these objects are achieved by providing at the remote location, in the example to be described in the in-

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stant case on the underwater buoy, a normally unenergized and inoperative receiver including means for demodulating a carrier wave signal and having coupled to its output a circuit, means which is responsive to a particular modulating frequency for actuating the desired control function, e.g., the release of the buoy. Coupled to the input circuit to the receiver is a normally unenergized frequency-selective switching circuit which upon receipt of a signal of a preselected carrier frequency will connect the receiver to a power supply, thereby placing the receiver into an operative or "on" condition. The frequency-selective circuit is further provided with means to disconnect the power supply from the receiver after a preset period of time which is longer than the time required for the desired control function to be completed. The control function is not initiated unless the particular modulating frequency is received during the preset period of time.

The objects and advantages of this invention will be more easily understood from the following detailed description when taken in conjunction with the attached drawings, wherein:

FIGURE 1 is a cross-sectional view of an underwater buoy including an unlatching mechanism with which applicant's novel control circuit may be used;

FIGURE 2 is a schematic diagram of the control circuit embodying the present invention; and,

FIGURE 3 is a schematic diagram of alternative output circuits which may be used with the circuit of FIGURE 2.

Referring now to FIGURE 1, there is shown a buoy which is similar to the buoy disclosed in the aforementioned patent, comprising a buoyancy tank 10 and a buoy-line housing 11 which are held together by means of a tubular member 12 extending axially through the buoyancy tank 10 and the housing 11. Coiled within the buoy-line housing 11 is a suitable length of buoy line 13 whose upper end is connected, as at 14, to the housing 11. The lower end of the buoy line 13 extends through an opening in the bottom of the housing 11 and is connected by means of an eye bolt 15 to an anchoring mechanism 16 which anchors the buoy line 13 to a container 17 fastened to an underwater installation (not shown).

The buoy apparatus is maintained in the container 17 by means of spring-loaded latching dogs 18 which are pivoted to extend outwardly beyond the vertical wall of the buoy-line housing 11 so as to latch in a cooperating slot 19 formed in the wall of the container 17. Mounted on top of the buoy-line housing 11 is a pressure-tight housing 20 containing the circuitry shown in FIGURE 2 for withdrawing the latching dogs 18 from the slot 19 upon actuation of the circuitry by a properly coded signal transmitted from a barge on the surface of the water.

Referring now to FIGURE 2, there is shown a control system consisting generally of a power supply, a power-saving circuit, a receiver, and an output circuit for performing the desired control function. The system is designed to respond to a carrier wave of a first predetermined frequency which has been amplitude-modulated by a signal of a second predetermined frequency; the frequency of the carrier wave is used to actuate the power-saving circuit which connects the power supply to the receiver and the frequency of the modulating signal is used to actuate the aforementioned output circuit which in the instant application actuates a solenoid to release the latching dogs 18.

The input to the control system is a transducer 30, e.g., a piezo electric crystal, for converting sonic waves to electrical signals. Preferably the transducer has an output response characteristic which increases measurably or peaks at the frequency of the selected carrier wave. In the instant example, the carrier frequency is preferably chosen so as to avoid audio frequency sea noise and the

standard echo-ranging frequencies without going to frequencies so high that high attenuation in water becomes objectionable, e.g., 30 kilocycles.

The output voltage signals from the transducer 30 are applied by means of a conductor 31 and variable inductance 32 across the primary winding 33 of a transformer 34 which forms the input to the power-saving portion of the control system. The variable inductance 32 is adjusted so that the input to the transformer 34 is in series tuned with the output impedance of the transducer 30 to resonate at the predetermined carrier frequency. The output signals from the secondary winding 35 of the transformer 34 are rectified by a diode 36 and then fed to a sensitive meter-type relay, indicated generally by the numeral 37, which consists of a meter movement 38 connected across the secondary winding 35, a pair of normally open contacts 39, 40, and a locking coil 41 having one of its ends connected to relay contact 39 and its other end connected to the negative terminal of a direct-current power supply 45, such as a battery of cells. The positive terminal of power supply 45 is connected to a point of reference potential hereinafter referred to as ground. In other suitable arrangements, the polarity of the direct-current power supply 45 might be reversed. A pair of oppositely poled stabistor-type diodes 46, 47 (a diode which is internally biased to conduct only above a predetermined voltage) is also connected across the secondary winding 35 to protect the meter relay 37 from overload.

The output of the power-saving portion of the control system comprises a relay 48 having one end of its relay coil 49 and its armature 50 connected to contact 40 of meter relay 37. The normally open contact 51 is connected through a variable resistor 52 and lead 53 and through lead 54 to the power input terminals 55 of the receiver portion of the control system. The variable resistor 52 is adjusted so that the proper supply voltage will be applied to the receiver upon the closing of the relay 48. The other end of the relay coil 49 is connected to ground in series with a capacitor 56, the purpose of which will be more fully explained later.

When the transducer 30 receives a signal containing the predetermined carrier frequency, a voltage is produced across the secondary winding 35 of the transformer 34 which is of sufficient magnitude to energize the meter relay 37 thus closing contacts 39 and 40. Closure of contacts 39 and 40 will complete the electrical path between the direct-current power supply 45 and the relay 48, which will then become energized and close relay contacts 50 and 51. Closure of these latter relay contacts permits power from source 45 to be applied to the receiver portion of the control system via conductors 53 and 54. As just described, the power saving circuit, once it has been energized, will remain energized even though the predetermined frequency signal is no longer being received by the transducer 30. This is due to the locking coil 41 of the meter relay 37 which will maintain the contacts 39, 40 in a closed position until the current through the locking coil 41 is stopped or reduced to such a value that the contacts 39, 40 will open. Since it is possible that a spurious noise signal containing the predetermined carrier frequency could energize the meter relay 37 and start a slow continuous drain of the battery supply 45, such a condition cannot be tolerated. It is to prevent such an occurrence that the capacitor 56 in series with relay coil 49 is provided. As soon as the contacts 39, 40 are closed the capacitor 56 will begin to build up a negative charge. After a period of time, e.g., one second, the charge of the capacitor 56 will be sufficient to bias the relay coil 49 to such a value that it will become de-energized causing contacts 50, 51 to open and stopping the flow of receiver current through the locking coil 41. The remaining current flowing through the locking coil 41 will then be insufficient to maintain the

contacts 39, 40 in a closed position. Once these contacts have opened, the capacitor 56 will discharge through a resistor 57 connected in parallel with capacitor 56 and thereby place the circuit in a condition to be energized by a genuine signal of the proper frequency.

It is possible however, for the spurious signal to last for a period of time greater than the time required to build up a sufficient charge on the capacitor 56 to de-energize relay 48. In this case the meter relay contacts 39, 40 will remain closed and maintain the charge on capacitor 56. This will result in the relay 48 remaining de-energized and preventing the receiver from operating on genuine signals. To prevent this latter occurrence, a "four layer" or Shockley diode 58 in series with a resistor 59 is connected in parallel with the capacitor 56.

The Shockley diode functions as a voltage sensitive switch. It appears to be an open circuit until the voltage at its terminals reaches a certain value at which time the diode breaks down. After the diode has broken down, it appears as a short circuit as long as a minimum current is maintained through the diode. In the instant application, in the event that the meter relay contacts 39, 40 do not open after the relay 48 is de-energized, the capacitor 56 will continue to build up a charge until the voltage across the diode 58 is sufficient to break it down. The diode then appears as a short circuit across the capacitor 56 and consequently discharges capacitor 56. The resistance of the relay coil 49 and the resistor 59 in series with the Shockley diode 58 keep the current through the diode below the required minimum so that the diode returns to its open circuit condition immediately after breakdown.

During the time that the relay 48 is energized, the receiver is capable of amplifying and demodulating the incoming signals. The signal which was applied to the primary winding 33 of transformer 34 is applied by means of lead 60 and coupling condenser 61 to the input terminal 62 of a receiver which includes in series, a carrier frequency amplifier 63, a diode demodulator 64, a modulation frequency amplifier 65, and a power amplifier 66. Connected in the emitter circuit of the last stage of the power amplifier 66 is the relay coil 70 of a resonant relay 71 having a vibrating reed contact 72 and a stationary contact 73 which is connected to the negative terminal of the battery 45 by means of conductor 74. The vibrating reed 72 is connected in series with a solenoid 75 to ground. A capacitor 76 in series with a resistor 77 is connected across the solenoid 75 to protect the contacts of resonant relay 71 and to insure the proper operation of solenoid 75. The resonant relay 71 is very sharply tuned to the predetermined modulating frequency and due to power amplification of any detected signal will be energized by only a few cycles. If the carrier frequency has been modulated by the predetermined frequency, then the contacts 72, 73 will close and connect the battery 45 across the solenoid 75 causing the solenoid to withdraw the latching dogs 18 from the slot 19.

Referring now to FIGURE 3, there are shown a number of alternative output circuits which may be used in place of solenoid 75 it is desired that once the proper modulated carrier frequency signal has been received that the output remain energized. The solenoid 75 of FIGURE 2 may be replaced by a relay coil 80 which controls a pair of normally open contacts 81, 82. Contact 81 is connected to the negative terminal of battery 45 by means of a conductor 83 which is connected to lead 74 of FIGURE 2. Contact 82 is connected by means of a properly poled diode 84 to contact 72 and to output terminal 85 through normally closed switch 86. A solenoid or any other type of control device may be connected across the output terminals. With the circuit just described, when the relay 71 (FIGURE 2) has been energized, power will be applied to relay coil 80 which

will then close contacts 81, 82. Closure of these contacts will apply power from the battery 45 to the output terminal 85 via leads 74 and 83, contacts 81, 82 and switch 86. Closure of contacts 81, 82 will also lock the coil 80 in an energized condition due to the current which flows from the contact 82 through the diode 84.

If a pulsed output at terminal 85 is desired, the switch 86 is opened. In this case, upon closure of the relay contacts 81, 82, the voltage from source 45 instead of being applied directly to the terminal 85, will cause a current to flow through the diode 87 and resistor 88 and charge the condenser 89 until it reaches a value of charge sufficient to break down the Shockley diode 90 and discharge the capacitor through the load impedance (not shown) connected across the output terminals. Since the contacts 81, 82 are maintained in a closed position due to the diode 84, the capacitor 89 will be alternately charged and discharged thus producing a pulsed output signal at terminal 95.

Although the system has been described using an amplitude modulated carrier wave signal to perform the control function, it is understood that the other types of modulation may be used without departing from the spirit of the invention. A control system responsive to an amplitude modulated control signal is preferred however, since there is little likelihood of such a signal occurring naturally and a system responsive to such a signal requires the least complicated release circuitry.

It is also understood that although the control system has been disclosed for a buoy release mechanism, it is not limited to this application but may be used for other purposes such as remotely controlled releases for flares, rockets, etc., actuation of fire fighting equipment or the like.

I claim as my invention:

1. In combination with a submerged marine marker buoy which is releasably latched to an underwater installation and anchored thereto by a buoy line, a normally unenergized buoy release system mounted on said buoy which is responsive to a modulated carrier wave sonic signal of a preselected carrier frequency, said buoy release system comprising: a transducer for converting said sonic signal to electrical signals; a direct-current power source; first normally unenergized and inoperative circuit means coupled to the output of said transducer for demodulating said carrier wave; second normally unenergized circuit means coupled to the output of said transducer and actuated by an output signal from said transducer of said preselected carrier frequency for connecting said power source to said first circuit means to energize said first circuit means and render it operative; electrically actuated unlatching means for said buoy; and means coupled to the output of said first circuit means and responsive to a preselected modulating frequency for actuating said unlatching means, whereby said buoy will rise to the surface.

2. The apparatus of claim 1 wherein said second circuit means includes means actuated by the reception of said predetermined carrier frequency for disconnecting said power source from said first circuit means after a fixed time interval.

3. The apparatus of claim 2 wherein, after said fixed time interval, said disconnecting means normally remains energized and keeps said first circuit means disconnected from said power supply until the reception of said carrier frequency has stopped; said second circuit means further including, means for deactuating said disconnecting means after a period of time longer than said fixed time interval.

4. A remote-control system requiring no consumption of power when in a stand-by condition and adapted to respond to a modulated carrier wave of a preselected carrier frequency comprising: a normally unenergized and inoperative receiver, said receiver including means for

demodulating said carrier wave; a source of power; normally unenergized circuit means connected to the input of said receiver and actuated by an input signal of said preselected carrier frequency for connecting said receiver to said source of power to render said receiver operative and for subsequently disconnecting said source of power from said receiver after a preset time interval and thereby returning said receiver to an inoperative condition; and means responsive to the output signals from said receiver for effecting the desired control function.

5. The apparatus of claim 4 wherein said means responsive to the output signals from said receiver is responsive to a predetermined modulating frequency.

6. The apparatus of claim 4 wherein said means for connecting and disconnecting said power source to said receiver normally remains in an actuated condition after said preset time interval until said carrier frequency signal has ceased; and means for deactuating, after a period of time longer than said preset time interval, the said means for connecting and disconnecting said power source to said receiver.

7. A modulated carrier wave-controlled remote control system requiring no consumption of power when in a stand-by condition comprising: an input circuit; a receiver connected to said input circuit, said receiver including means for demodulating a carrier wave appearing in said input circuit; a source of power; first circuit means responsive to a predetermined carrier frequency coupled to said input circuit, said circuit means including a circuit tuned to said predetermined carrier frequency and a meter relay responsive to the output signal from said tuned circuit, said meter relay having a pair of contacts and a locking coil connected in series with said source of power; relay means connected in series with said contacts and responsive to the closure of said contacts for connecting said power source to said receiver so that the latter can demodulate any incoming carrier wave signals; and means connected to the output of said receiver and responsive to an output signal of a predetermined modulating frequency for carrying out the desired control function.

8. The apparatus of claim 7 wherein said relay means includes a relay coil connected in series with said relay contacts and said locking coil of said meter relay, and a pair of normally open-relay contacts, one of which is connected to one of said meter relay contacts and the other of which is connected to supply power to said receiver; and means coupled to said relay coil for de-energizing said relay coil after a preset interval of time even though said meter relay contacts remain closed.

9. The apparatus of claim 8 wherein said means for de-energizing said relay coil after a preset interval of time comprises a capacitor in series with said relay coil, said capacitor connecting said relay coil to the grounded side of said source of power.

10. The apparatus of claim 9 including means connected across said capacitor for discharging said capacitor after a period of time longer than said preset interval of time.

11. The apparatus of claim 10 wherein said last-mentioned means comprises a resistor and a four-layer diode connected in series.

12. The apparatus of claim 8 wherein said means connected to the output of said receiver and responsive to a predetermined modulating frequency for carrying out the desired control function comprises: a sharply-tuned resonant reed relay; a control device; and means connected to the contacts of said resonant reed relay for connecting said power source to said control device when said contacts are closed in response to said predetermined modulating frequency.

13. The apparatus of claim 11 wherein said means connected to the output of said receiver and responsive to a predetermined modulating frequency for carrying out the desired control function comprises: a sharply-tuned

resonant reed relay; a control device; and means connected to the contacts of said resonant reed relay for connecting said power source to said control device when said contacts are closed in response to said predetermined modulating frequency.

14. A remotely controlled system requiring no consumption of power when in a standby condition and which is responsive to a modulated carrier wave signal of a preselective carrier frequency comprising:

a normally unenergized and inoperative receiver, said receiver including means for demodulating said carrier wave;

a source of power;

first normally unenergized circuit means connected to the input of said receiver and responsive to an input signal of said preselected carrier frequency for connecting said receiver to said source of power to render said receiver operative, said circuit means including a circuit tuned to said predetermined carrier frequency and switching means responsive to the output signal from said tuned circuit; and, means responsive to the output signals from said receiver for affecting the desired control function.

15. The apparatus of claim 14 including second normally unenergized circuit means actuated by the actuation of said first circuit means for causing said switching means to disconnect said receiver from said source of power after a preset time interval.

16. The apparatus of claim 15 wherein after said pre-

set time interval, said means for disconnecting said receiver from said source of power normally remains in an actuated condition until said carrier frequency signal has ceased, thereby rendering said first circuit means ineffective to reconnect said receiver to said source of power; and, means for deactuating said second circuit means after a period of time longer than said preset time interval.

17. The apparatus of claim 14 wherein said switching means comprises: first and second relay means, said first relay means being connected to the output of said tuned circuit and responsive to an output signal therefrom to connect said source of power to said second relay means to energize said second relay means, said second relay means, when energized, connecting said source of power to said receiver.

18. The apparatus of claim 17 including means for de-energizing said second relay means after a preset interval of time.

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