

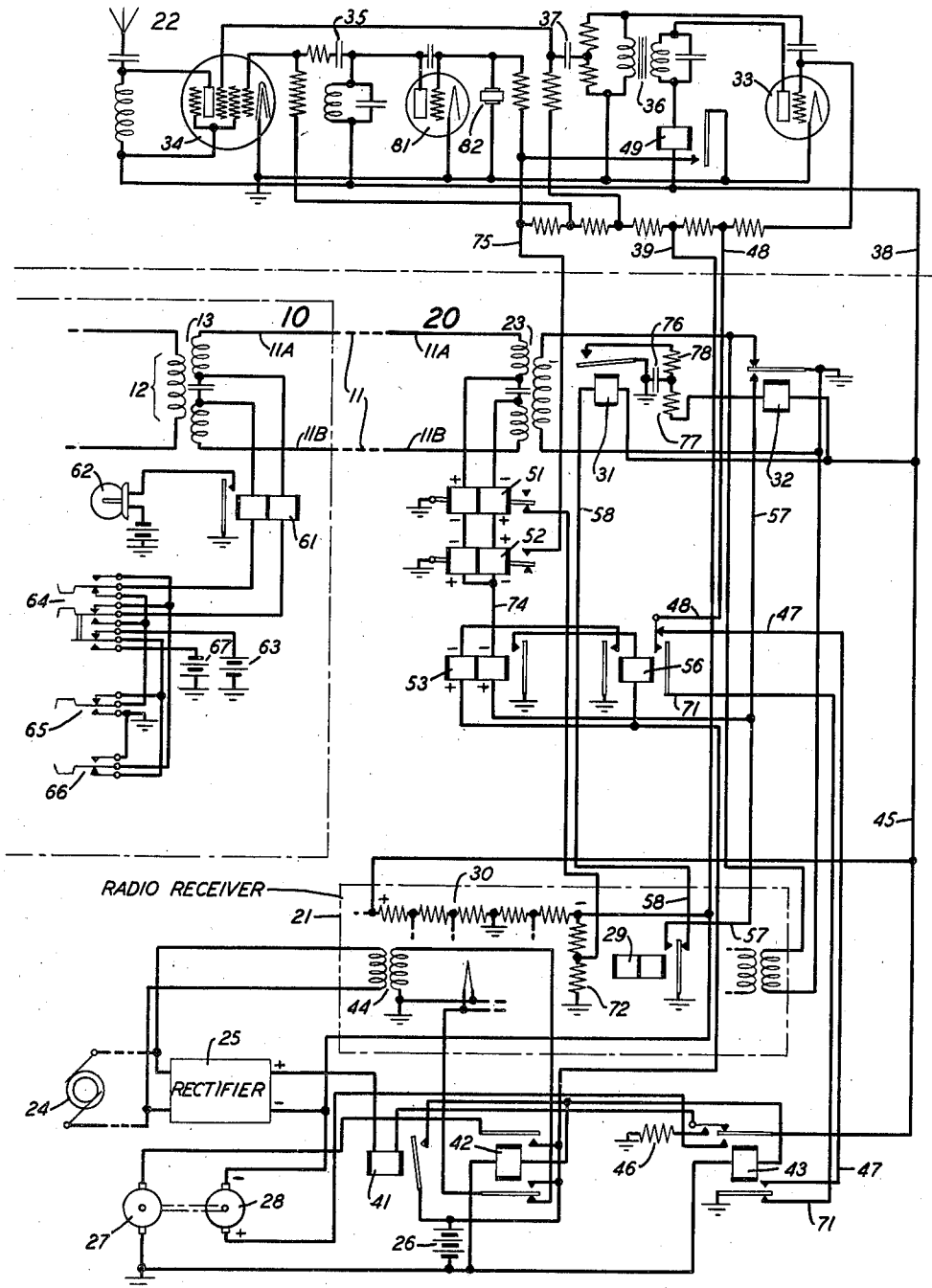
Feb. 11, 1941.

H. M. PRUDEN

2,231,636

RADIO RECEIVER CONTROL SYSTEM

Filed Aug. 9, 1939



INVENTOR
H. M. PRUDEN
BY *George C. Lord*
ATTORNEY

UNITED STATES PATENT OFFICE

2,231,636

RADIO RECEIVER CONTROL SYSTEM

Harold M. Pruden, Maplewood, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application August 9, 1939, Serial No. 289,203

10 Claims. (Cl. 250-6)

This invention relates to control and indicating circuits and particularly to such circuits for use in radio telephone systems employing radio receivers remotely located with respect to the control or central station.

With certain types of radio telephone service, for example, between small ships and shore and certain types of point-to-point service, it is desirable to employ unattended radio receivers located remote from the central or control station. While with modern technique such receivers can be so built that they are largely self-operating, it is still desirable to provide certain control. These include the use of test oscillators for monitoring the operation of the receiver as well as the communicating transmitters, certain adjustments of the receivers sensitivity and emergency power control. It is further desirable that these controls be effected with the use of as few connecting lines as possible.

An object of the invention is to provide, for a radio receiver located remote from an operating point, control circuits which utilize a minimum of apparatus and line facilities.

The drawing is a schematic circuit diagram of one embodiment of the invention.

In the drawing there is shown the radio receiving portion of a radio telephone system. This comprises a central station 10 which is connected through a telephone line 11 to a radio receiver station 20 which is arranged for unattended operation and controlled from the central station 10 over the line 11.

The central station is provided with apparatus for controlling the radio receiver and its auxiliary equipment, as will be described in detail hereinafter. In the usual system, this central station will also be provided with facilities whereby the voice circuit output 12 of the radio receiver may be connected to a land telephone line of the usual type along with the input voice circuit to a radio transmitter, thus permitting two-way transmission over the radio link. Such circuits and apparatus are well known in the art and are not shown herein for the reason that they do not form part of the present invention except in so far as a primary object thereof is for cooperation in such systems.

At the radio receiver station 20 there are provided a radio receiver 21, a test oscillator 22, control and power supply circuits. The voice output of the radio receiver 21 is connected to the telephone line 11 through a transformer 23. At the central station the line 11 is connected to the telephone voice circuit through another trans-

former 13. The line windings of both of the transformers 23 and 13 are divided to provide direct current control circuits over the line 11 in addition to the voice circuit.

For normal operation, power for the radio receiver 21 and the test oscillator 22 is provided from an alternating current source or power system 24 by means of a rectifier 25. In addition, emergency power supply is provided comprising a low voltage storage battery 26 and a motor generator set including a motor 27 and a high voltage generator 28. An automatic control circuit is provided so that upon failure of the alternating current supply 24 the power supply for the receiver station will be automatically switched to the battery 26 and motor generator set 27-28. In the case of such action an indication of the operation of the circuit will be given at the central station 10. This circuit also operates to switch the power supply back to the alternating current source 24 upon the restoration of such service and to give an indication at the central station 10 of such operation.

The radio receiver 21 is of a well-known type and, consequently, is not shown in detail. Only those portions essential to the operation of the invention are indicated. As is well understood in the art, it will be provided with automatic volume control for maintaining its output substantially constant over a wide range of input levels. However, it has been found desirable in the operation of systems of this type to provide a general control of the gain of the receiver, particularly to maintain an adequate signal-to-noise ratio. For this purpose there is provided a control circuit which permits operation of the radio receiver at two different gain levels. For this purpose the radio receiver is normally operated with high gain and a circuit controlled from the central station 10 is provided for reducing the receiver gain to meet the operating conditions where such an adjustment is preferable.

Since it is intended that the radio receiver form part of a telephone circuit, it is arranged for continuous operation and, consequently, no provision is made for turning the receiver on and off from the central station.

The receiver is further provided with a Codan circuit (carrier operated device anti-noise). Such a circuit is well understood in the art and may, for example, be of the type shown in Garfield Patent 2,098,285 of November 9, 1937. With such a circuit, the voice output of the receiver is disabled under normal conditions, that is, when

no signal is being received. However, in the presence of a received carrier wave, the Codan circuit will function to render the receiver operative. This function is performed by the Codan relay 29 of the receiver which cooperates with the relays 31 and 32, as will be hereinafter described in detail. The same circuit is also used to operate a visual indicator at the central station 10, thus notifying the operator that a signal is being received by the radio receiver. For this purpose the Codan relay at the receiver station closes a simplex line circuit to operate the signal relay at the central office. This signal relay may also be used to control the switching of the radio transmitter to and from the subscriber's line. Thus, when the radio receiver Codan operates in response to a received carrier, the radio transmitter will be disconnected from the subscriber's line.

The other functions of the control circuit are for the control of the test oscillator 22 which may be used both to test the operation of the receiver 21 and for monitoring the frequency of radio transmitters communicating with the receiver. This oscillator is also used for giving the indication of the operation of the power supply circuit.

The test oscillator 22 comprises a radio frequency oscillator tube 81 which is controlled by a piezoelectric crystal 82 to operate at the frequency to which the radio receiver 21 is tuned. There is also included an audio frequency oscillator tube 33 which generates an audio frequency tone suitable for modulating the radio frequency output of the oscillator 81. For this purpose a multigrid modulator tube 34 is provided. The output of the radio frequency oscillator tube 81 is coupled to the inner control grid of this tube through the coupling condenser 35. For unmodulated operation, the tube 34 is operated simply as an amplifier. For modulated operation, the tuned circuit 36 of the audio frequency oscillator is coupled to the outer control grid of the modulator tube 34 through the coupling condenser 37.

Power supply for the test oscillator both for operation and control is obtained in parallel with the power supply for the radio receiver 21. Positive plate voltage is supplied through the lead 38. Negative voltage with respect to ground is supplied through the lead 39. Under normal conditions both the radio frequency oscillator 81 and the audio frequency oscillator 33 are maintained inoperative by negative bias voltages supplied to their control grids through the circuits shown. The operation of the control relays for rendering the oscillator tubes operative will be described in connection with the various control functions.

Power supply

Under normal conditions, power is supplied to the radio receiver 21 and test oscillator 22 from the alternating current line 24 through the rectifier 25.

This circuit may be traced from the positive terminal of the rectifier 25 through the winding of the relay 41, outer contact and armature of relay 43, to the positive terminal of the voltage divider 30 of the radio receiver. The negative terminal of this voltage divider is permanently connected to the negative terminal of the rectifier and the negative terminal of the generator 28. As long as the rectifier 25 is supplying direct current, the relay 41 will remain operated due to the current flowing through its winding.

Upon the failure of the rectifier power supply, due either to interruption of the alternating current supply 24 or difficulty with the rectifier 25, the power supply is transferred to the low voltage battery 26 and the motor generator 27-28. When this emergency power supply control circuit operates, an indication is also given at the central office 10. This indication is obtained by turning on the test oscillator 22 in the modulated position which will supply modulated radio frequency to the input of the radio receiver 21, operate the Codan relay so as to open the voice frequency circuit and operate the indicator at the central station in the same way as when a signal is received by the receiver. By listening, however, the operator will be made aware of the operation of the power supply circuit due to the presence of the distinctive tone from the test oscillator.

Since the circuit cannot be used while the tone is on, an additional control circuit is provided so that the operator may disconnect the tone after the power failure has been noted.

The operation of the power control and indicating circuit will now be described in detail. Upon the failure of the rectified power supply, relay 41 will release. This establishes a circuit from the positive terminal of the battery 26 through armature and contact of the relay 41 and the winding of relays 42 and 43 in parallel to the grounded negative terminal of the battery 26. This operates both relays 42 and 43. The operation of relay 42 completes a circuit through its upper armature for supplying low voltage from the battery 26 to the motor 27. At the same time the supply for the filaments of the radio receiver 21 is transferred from the transformer 44 to the battery 26 through the movement of the lower armature of relay 42 from its outer to its inner contact.

The operation of relay 43 transfers the high voltage lead 45 from the rectifier 25 to the generator 28. The new connection may be traced from the positive terminal of the generator 28 through the inner contact and upper armature of relay 43, to the lead 45. At the same time, the two outer contacts of the relay 43 are closed to connect a temporary load resistor 46 to the winding of the relay 41.

The lower armature and contacts of the relay 43 perform the function of operating the alarm circuit to give an indication at the central station 10 of the operation of the power supply control circuit.

This alarm circuit operates by starting the test oscillator 22 in its modulated condition. This supplies a modulated radio frequency wave to the receiver 21 which operates the Codan circuit of the receiver.

This circuit may be described in detail as follows: The operation of relay 43 connects the lead 47 to ground through the lower armature and inner contact of the relay 43. This ground connection may be traced from the lead 47 through the inner right-hand contacts of relay 56 to lead 48. The grounding of this lead 48 of the test oscillator removes the negative bias from the control grid of the audio frequency oscillator 33, causing the oscillator 33 to start. The resulting flow of plate current operates the relay 49 to ground the grid of the high frequency oscillator tube 81 through the armature of relay 49, causing the radio frequency oscillator 81 to start. Thus, both oscillators supply voltage in

the modulator tube 34, producing a modulated radio frequency wave in the output of the oscillator.

The reception of the modulated audio frequency wave by the receiver 21 causes the operation of the Codan relay 29. This grounds the lead 57 through the armature and inner contact of relay 29, at the same time removing the ground connection from the lead 58. The latter operation releases the relay 31 by opening the circuit of its operating winding. The release of relay 31 operates the relay 32 by closing the circuit for its operating winding to ground through the armature and outer contacts of relay 31. This removes the short circuit from the receiver winding of the transformer 23, thus rendering the voice channel operative.

The grounding of the lead 57 closes the simplex circuit over the line 11 and through the two windings of the relay 51 (at the central station 10) in parallel to operate that relay. This gives an indication at the central office 10 by lighting the signal lamp 62.

This circuit may be traced from the positive terminal of battery 63 through the unoperated keys 64, 65 and 66, windings of relays 61, in parallel, the simplex circuit of the line 11, through the opposing windings of relays 51 and 52, the operating winding of relay 53, lead 57 to ground. As indicated on relay 53, the direction of current flow through the winding of that relay is such as not to operate the relay.

When the operator at the station 10 observes the lighting of the signal lamp 62 and hears the audio tone transmitted over the line 11, the failure of the power supply is noted. The test oscillator may now be stopped by an appropriate action by the operator, to permit the use of the radio receiver with emergency power supply. This operation is performed by closing key 64. This supplies negative battery to both sides of the telephone line 11 from the battery 67. At the receiver station the circuit is completed from the two sides of the telephone line 11 through the windings or relays 51 and 52, and the operating winding of relay 53 to ground. Since the current is flowing in the opposite direction through their respective windings, relays 51 and 52 will not operate. However, relay 53 is operated. The operation of relay 53 operates relay 56, which in turn stops the test oscillator by the opening of the inner right-hand contact of relay 56 which removes the ground connection at 48 and restores the negative bias to the grid of tube 33. At the same time the relay 53 is locked up by the circuit for its locking winding being closed through the left-hand contact of relay 56.

After these operations, the receiver is in condition for operation from emergency power supply with no signal tone supplied from the test oscillator over the telephone line. The turning off of the test oscillator of course releases the Codan relay 29 of the receiver and, consequently, restores the relays 31 and 32 to their normal positions, namely, with relay 31 operated and relay 32 released.

When normal alternating power supply is restored, the relay 41 operates by current flowing from the positive output terminal of the rectifier 25 through the relay winding and resistor 43. This operates relay 41, causing the release of relays 42 and 43 which transfer the power supply circuit to the rectifier and the filament supply circuit to the transformer 44 and disconnect the motor 27 from the battery 25.

The release of relay 43 also opens up the ground connection 47 and grounds the connection 71. This turns the test oscillator 22 on again in the modulated condition and signals the operator at the station 10 in the same manner as when power is transferred from normal to emergency power supply.

This is accomplished because, in the condition of emergency power supply, the relay 56 is operated so that the grounded connection 71 is transferred to the connection 48 for the test oscillator through the right-hand armature and inner contact of relay 56.

Under such conditions, the test oscillator may be turned off from the central station 10 to permit normal operation by releasing the key 64. This operation of the key supplies positive battery to both sides of the line 11. Thus current flows through the operating winding of relay 53 to ground through the inner contact and armature of relay 32 which has been operated by the output of the test oscillator received by the radio receiver 21. This current is in such direction and of sufficient magnitude to overcome the effect of the current in the locking winding, thus causing the relay 53 to release.

Control circuits

Keys 65 and 66 are provided for controlling the gain of the receiver and the operation of the test oscillator. Instead of separate keys, these may be combined into one three-position key.

It will be noted that the operation of the key 64 at the central station 10 is such that in the normal or released position of the key for normal power supply positive battery will be applied to both of the conductors of the line 11, while for emergency power supply with the key 64 operated negative battery will be supplied to both sides of the line. The operation of the circuit for the change of gain and control of the oscillator is the same in both cases with the exception of this reversal of polarity. Only the operation for the normal condition with the key 64 released and positive battery supplied to the line will be described in detail.

In this condition, as illustrated by the position of the key 64 in the drawing, neither of the relays 51 or 52 will be operated as the currents divide equally between the opposing windings of each.

Gain control

To operate the gain control circuit, the key 65 is operated. This removes the positive battery connection from the conductor 11B of the line 11 and instead grounds that connection. This operates the relay 51, opening the circuit through its armature and contact and, consequently, opening the short circuit on the resistor 72 of the radio receiver. This increases the negative bias on certain of the amplifier tubes of the receiver and, consequently, decreases the gain.

The detailed circuit for the operation of relay 51 is as follows: Current flows from the positive terminal of battery 63 through lower contacts of key 64, key 66, middle contact of relay 64, right-hand winding of relay 51, line wire 11A, left-hand winding of relay 51, two windings of relay 52 in series, right-hand winding of relay 51, line wire 11B, left-hand winding of relay 61, upper contact of relay 64, key 65 (in operated position) to ground. The current is in the proper direction to operate relay 51 while it will not operate relay 52.

It should be noted that in this condition current flows in opposite directions through the two windings of relay 61 so that that relay does not operate. If, with the circuit in the condition just described the Codan relay 29 of the receiver operates, operating relay 32 to apply a ground to connection 74, the left-hand winding of relay 61 is effectively short-circuited, thereby causing the operation of the relay 61 by the current flowing through its right-hand winding.

Oscillator control

In order to turn on the test oscillator in the unmodulated position, key 66 is operated. This removes the positive battery from the line 11A and instead grounds that line. In this way there is set up for relays 51 and 52 a circuit similar to that for operation of the gain control except that in this case the current is in the opposite direction so that relay 52 operates while relay 51 remains unoperated. The operation of relay 52 grounds the connection 75, thus removing the negative bias from the grid of tube 81 and causing that tube to operate, giving an unmodulated radio frequency output from the test oscillator 22. This output may be used to compare the frequency of signals being received by the receiver 21 with that of the output of oscillator 81.

By proper operation of the control keys, the test oscillator 22 may be caused to operate with a modulated output. This permits a test from the central station 10 to determine whether the radio receiver 21 is operating properly.

This test can be made by closing both keys 64 and 66. With the keys in this position, negative voltage from the battery 67 is applied to the line conductor 11A and the conductor 11B is grounded. The effect of this at the receiver station 20 is to operate relay 52, which puts ground on the connection 75, causing the oscillator 22 to start up in its unmodulated condition. The unmodulated output of the oscillator being received causes the radio receiver Codan relay 29 to operate. As previously described, this causes the release of relay 31 and the operation of relay 32 which removes the short circuit from the radio receiver output and grounds the control circuit at the central office 10.

At the same time, the grounding of the lead 57 by the operation of the Codan relay 29 completes the circuit for the operating winding of relay 53 so that current from the central office battery 67 over line 11A causes the operation of relay 53. This, in turn, operates relay 56, putting ground on connection 48 which starts the tone oscillator tube 33 to modulate the output of oscillator 22. The operation of oscillator tube 33 causes the operation of relay 49, maintaining the radio oscillator tube 81 in an operating condition until the ground is removed from connection 48 even though the keys 66 or 65 are moved to their other positions. As a result, after the foregoing operations have been performed, the key 65 may be operated to test the receiver 21 in its low gain condition with the modulated output of oscillator 22.

Codan circuit

As described above, the Codan relay 29 of the radio receiver controls the relays 31 and 32 to remove the short circuit from the radio receiver output in the presence of a received carrier and through the inner contact of relay 32 to control the indicating relay 61 at the central station 10. In order to eliminate false release of the relay 32, this relay is given a hang-over time by the ac-

tion of condenser 76 and resistor 77. A second resistor 78 is provided to protect the contacts of relay 31 when the condenser 76 is being discharged.

What is claimed is:

1. In a radio telephone system, a control station, a radio receiver located remote therefrom, a telephone line interconnecting the control station and the output of said radio receiver, a Codan circuit including means for normally blocking said line to the transmission of audio signals and responsive to received carrier waves in said receiver for unblocking said line, a power supply normally connected to said receiver, an emergency power supply for said receiver, power supply control means normally responsive to the failure of said normal power supply for automatically connecting said emergency power supply to said receiver, a normally inoperative source of audio modulated high frequency waves of the frequency to which said receiver is responsive, and means responsive to the operation of said power supply control means for rendering operative said source to transmit an indicating signal over said line.

2. A system according to claim 1, including a control circuit operative over said line from said control station for rendering said oscillator inoperative.

3. In a radio telephone system, a control station, a radio receiver located remote from said station, a telephone line interconnecting the output of said receiver and the control station, a normal source of power supply for said receiver, an emergency source of power supply for said receiver, means responsive to the failure of the normal power supply for connecting the emergency power supply to the receiver, a source of audio modulated high frequency oscillations of frequency to which said receiver is responsive, normally inoperative, and means responsive to the operation of the power supply control means to render said source operative.

4. In a radio telephone system, a control station, a radio receiver, a telephone line connecting the output of said radio receiver with said control station, means for blocking the signal output of said radio receiver in the absence of received radio waves, a normally open simplex circuit for said telephone line including a relay and a source of direct current voltage of given polarity at said control station, a visual indicator arranged to be operated by said relay, a control relay at said receiver connected in said simplex circuit but so polarized as not to be operated by current from said source of given polarity, means responsive to received radio waves for unblocking the signal output of said receiver and simultaneously closing said simplex circuit, and means at said central station for reversing the polarity of said direct current source to operate said control relay.

5. In a radio telephone system, a control station, a radio receiver, a telephone line connecting the output of said receiver with said control station, a normally open simplex circuit for said telephone line including a relay at said control station, a relay at said radio receiver responsive to received carrier waves for closing said simplex circuit to operate said relay at said control station, a second relay at said radio receiver having two windings so connected to said line that said second relay is not operated by currents in said simplex circuit, and means at said control sta-

tion for producing a circulating current over said line to operate said second relay.

6. In a radio telephone system, a control station, a radio receiver, a telephone line connecting the output of said radio receiver with said control station, a normally open simplex circuit for said telephone line including a relay at said control station, a relay at said radio receiver responsive to received carrier waves for closing said simplex circuit to operate said relay at said control station, a pair of polarized relays each having two windings, one winding of each of said polarized relays being connected to each side of said telephone at the radio receiver terminal thereof so that said polarized relays are not operated by current over said simplex circuit, means at said control terminal for establishing in said telephone line a circulating current of such polarity as to operate one of said polarized relays to the exclusion of the other, and other means at said control station for establishing a circulating current of the opposite polarity to operate said other polarized relay to the exclusion of said one polarized relay.

7. A radio telephone system according to claim 6 and a gain control circuit for said radio receiver arranged to be operated by one of said polarized relays.

8. A radio telephone system according to claim 6 and a test oscillator at said radio receiver arranged to be rendered operative by the operation of one of said polarized relays.

9. A radio telephone system according to claim 6 including a gain control circuit for said radio receiver arranged to be operated by one of said polarized relays, and a test oscillator at said radio receiver arranged to be rendered operative by the operation of the other of said polarized relays.

10. In a radio telephone system, a control station, a radio receiver, a two-wire telephone line connecting the output of said radio receiver with said control station, a simplexed circuit operating with the two wires of said telephone line in parallel and a ground return and including at said control station a source of direct current of given polarity and a relay, said simplexed circuit also including at said radio receiver a pair of polarized relays each having two windings and a third polarized relay having a winding connected to the windings of one of said pair of polarized relays in parallel and each of said windings of said one of said polarized relays being connected in series with one of the windings of the other of said pair of polarized relays to each wire of said telephone line, said third polarized relay being unresponsive to current in said simplexed circuit from said direct current source of given polarity, means responsive to carrier waves received by said radio receiver for closing said simplexed circuit, a normal power supply for said radio receiver, an emergency power supply for said radio receiver, a test oscillator of frequency to which said radio receiver is responsive at said radio receiver, power control means responsive to the failure of said normal power supply for shifting to said emergency power supply, means responsive to the operation of said power control means for rendering said test oscillator operative, means at said control station for reversing the polarity of the current in said simplexed circuit to operate said third polarized relay, and means responsive to the operation of said third polarized relay for shutting off said test oscillator.

HAROLD M. PRUDEN.