

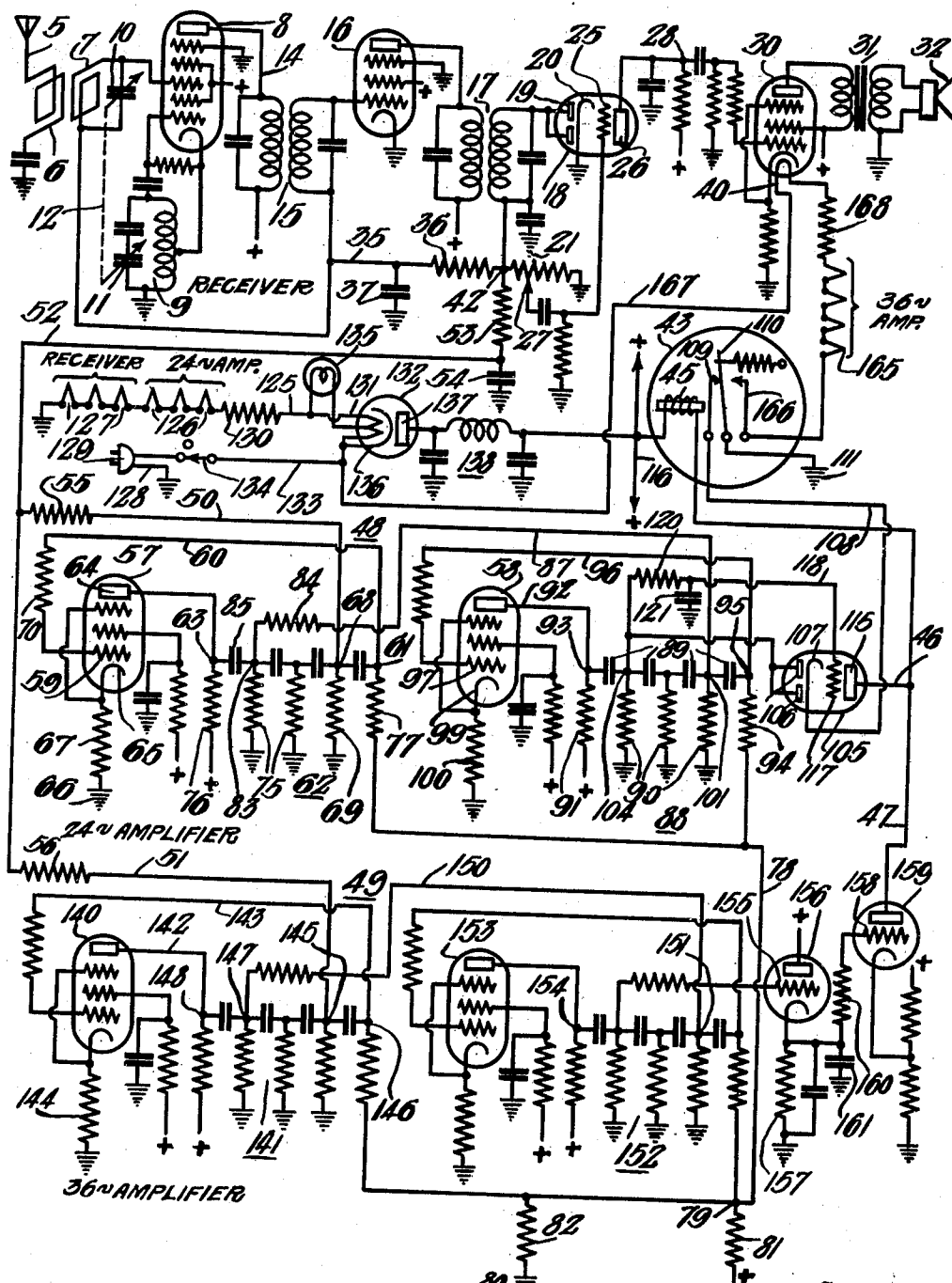
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RADIO AIR RAID WARNING SYSTEM

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## RADIO AIR RAID WARNING SYSTEM

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This invention relates to a radio air raid warning system, responsive to one or more subaudible control signals to reproduce intelligence transmitted on a carrier or mean frequency signal wave, and responsive to one or other subaudible control signals to restore the system to another condition of operation.

More particularly, this invention relates to a radio signal receiving system which is rendered responsive or non-responsive to broadcast signals or other intelligence transmitted by radio wave, when the radio wave is modulated by predetermined subaudible control signals preceding and following the intelligence transmission, and has for its object to provide a receiving system of the character referred to, embodying an improved and simplified tone or control signal selection network.

In tone controlled radio systems, a series of vibrating reed relays responsive to differing control frequencies are most frequently provided as the frequency selecting and control means. However, in accordance with the present invention, such relays and the fundamental disadvantages associated with their use, may be eliminated by substituting electrical circuits, including resistance-capacity networks in connection with suitable amplifiers, and in such a manner that a high degree of selectivity to control signals and greater reliability is achieved.

It is a further object of this invention, therefore, to provide an improved control arrangement for radio air raid warning systems and the like, wherein a plurality of parallel amplifier channels are provided, one for each tone or control frequency, embodying resistance-capacity networks in a plurality of stages, and with regenerative feedback for improving the selectivity characteristic of the system, and inverse or degenerative feedback for stabilizing the amplifier operation when utilizing a high degree of regenerative feedback.

With this arrangement, electrical, instead of mechanical, tone selection is made possible with a reduction in cost, in addition to simplifying the system.

The invention will, however, be further understood from the following description, when considered in connection with the accompanying drawing, and its scope is pointed out in the appended claims.

In the drawing the figure is a schematic circuit diagram of a signal receiving system provided with subaudible frequency control means embodying the invention.

Referring to the drawing, a source of signal energy is indicated by the antenna circuit 5 in which is located a coupling winding 6 associated with a signal input loop or inductance 7 for a detector-oscillator or mixer stage 8, the tunable oscillator circuit of which is indicated at 9. The input and the oscillator circuits are provided with tuning elements 10 and 11 of any suitable type such as variable capacitors as shown, preferably jointly operable, as indicated by the dotted connection 12, for tuning the system to selected signals in a predetermined frequency band.

The intermediate frequency output circuit 14 of the mixer stage is coupled through an intermediate frequency coupling transformer 15 to an intermediate frequency amplifier stage 16, which is coupled through a similar transformer 17 to a second or audio frequency detector 18. The latter comprises a diode rectifier having anode electrodes 19 and a cathode 20, connected with a suitable output impedance 21.

The detector 18 further includes an audio frequency amplifier stage comprising a control grid 25 and an anode 26 associated with the cathode 20. The grid is coupled through a variable volume control contact 27 with the detector output resistor 21.

The output circuit 28 from the anode is coupled to a suitable amplifier comprising an output amplifier stage 30, and the latter is coupled through an output transformer 31, with a loud-speaker device 32.

The receiving system proper may also include AVC means, which in simplified form comprises the second detector and the output impedance 21. In the present case, the D.-C. component of the rectified signal from the impedance 21 is applied to the AVC gain control circuit 35 for the mixer and I.-F. amplifier, through a suitable filter comprising a series resistor 36 and a shunt filter capacitor 37.

The system thus far described represents any suitable radio signal receiving system. However, in the case of a standby receiver system for air raid signals and the like, a minimum number of tubes is desirable, at least in the signal receiving portion thereof, to conserve power and to reduce operating cost as it is necessarily maintained energized for the reception of signals to which the system is tuned.

In any case, as in the present example, the receiving system is preferably readily tunable to a desired signal channel or broadcasting station from which signals are desired or expected, and includes automatic volume control means for

maintaining the signal intensity at the audio frequency detector substantially constant, and volume control means for adjusting the output signal level. The system operates to amplify, detect and reproduce a selected signal comprising a modulated carrier wave or mean frequency signal.

The mixer, intermediate frequency amplifier and audio frequency detector, which may be designated as the signal receiving portion of the system, must be energized whenever signals are to be received, which may include continuous operation over extended periods of time for air raid signal reception, while the audio frequency of power amplifying portion of the system may be deenergized in any suitable manner to conserve power and to increase the tube life. Also, to prevent noise and undesired signal reception, the sound output may be cut off in the absence of desired signals, and both control functions, that is, power conservation and the reduction of the sound output may be provided by deenergizing the cathode or heater circuit of the audio frequency amplifying system, and particularly the power output stage heater circuit. For this purpose, in the present example, the output or power amplifier cathode heater, indicated at 40, is normally deenergized, whereby signals to the loudspeaker 32 and the heavy anode current drain of the output stage or audio frequency amplifier are cut off in the absence of desired signals.

The output stage in the present example and the loudspeaker operation are controlled by sub-audible modulation frequency signals applied to the carrier wave, for example, a 24 cycle tone or control frequency is transmitted on the carrier for a few seconds just preceding important announcements or programs, and a 36 cycle tone or other subaudible control frequency signal is transmitted on the carrier just after the announcement or program. The 24 cycle control frequency signal causes the receiving system to be energized. In the present example, this comprises energizing the filament or heater 40 of the output stage. The 36 cycle control frequency signal deenergizes the receiver, as in the present example, by causing the filament or heater 40 to be deenergized.

The sub-audible control frequency signals may be derived from the receiving portion of the system at any suitable point preceding the de-energizable amplifying portion, such as at the high potential output terminal 42 of the second or audio frequency detector output impedance 21, and the signals so derived are utilized to operate a single relay device 43 which may be of simple conventional design, as distinguished from the usual number of tuned or vibrating reed relays normally used in systems of this character for control purposes.

In accordance with the invention, the relay operating winding 45 is connected in or otherwise coupled to the output circuits 46 and 47 of two parallel control channels 48 and 49, respectively, the input circuits 50 and 51 of which are connected with the subaudible signal supply terminal 42 through a supply lead 52.

The lead 52 includes a low pass filter comprising a series resistor 53 and a shunt bypass capacitor 54 for cutting off the audio frequency sound signals. The input circuits 50 and 51 also include suitable high resistance decoupling resistors connected at 55 and 56 which prevent the amplifying channels 48 and 49 from appre-

ciably loading the detector output impedance 21. These may each have a resistance of several megohms to prevent each selective amplifier from affecting the other.

Each of the amplifying channels 48 and 49 comprise a two stage amplifier and detector coupled by means of resistance-capacity networks. In the amplifying channel 48 the first stage amplifier is indicated at 57 and the second stage amplifier at 58. The first stage input grid 59 is connected through a lead 60 with the output terminal 61 of a resistance-capacity network 62 the input terminal 63 of which is connected with the anode 64 of the first stage to provide regenerative coupling between the anode and grid circuits. The cathode 65 is connected to ground which is the negative anode supply terminal through an unbypassed cathode resistor 67.

In the ladder type network 62, the signal input terminal for the network indicated at 68, is connected with the input circuit 50, whereby one resistor element 69 forms part of the input circuit as well as one of the elements of the network. The terminal 68 is next adjacent to the output terminal 61 so that the incoming sub-audible frequency signal is applied to the control grid 59 through part of the network 62. The feedback input terminal 63 of the network connected with the anode 64 is 180° out-of-phase with the output or grid terminal 61 so that regenerative feedback is applied to the grid 59 along with the incoming signal at a predetermined subaudible frequency.

The regeneration is prevented from extending into the oscillating range by means of degenerative feedback introduced into the input circuit through the unbypassed cathode resistor 67 which is of relatively high resistance to provide a high degree of negative or inverse feedback. A resistor 70 is also provided in the grid circuit 60 to prevent overload of the amplifier stage on noise pulses and to aid in preventing oscillations in the amplifier stage.

The filter network 62 providing 180° phase shift between the anode or input terminal and the output or grid terminal comprises a ladder circuit of shunt resistors 75 and the signal input circuit resistor 69 connected to ground, an anode coupling resistor 76 in the output circuit of the amplifier 57, and a bias supply resistor 77 connected with the output terminal 61 and the control grid 59. The resistor 77 is connected with a bias potential supply lead 78 which receives from a terminal 79 a potential which is positive with respect to ground 80 and the cathode, through a bleeder resistor comprising sections 81 and 82 in series. This is in opposition to the negative potential provided by the self bias resistor 67 and reduces the latter potential to a normal value for establishing a high gain through the stage.

The series elements of the network comprise capacitors 85 interposed between the resistor elements. Thus it will be noted that the various circuits associated with the resistor elements are effectively isolated for D.-C. potentials. This arrangement permits different D.-C. operating potentials to be applied to the various tube electrodes without D.-C. inter-coupling, while the desired signal or alternating current path is maintained through the filter network.

The output circuit of the stage 57 is coupled to the succeeding stage 58 through a circuit lead 87 connected through a suitable decoupling resistor

84 with a terminal 83 in the network preferably next adjacent to the anode or input terminal 63.

The second stage amplifier coupling network 88 is essentially the same as the network 62, comprising series capacitor elements 89 and shunt resistor elements 90. An anode coupling resistor 91 in the network is connected with the anode output circuit 92 at the network input terminal 93, and a grid bias supply resistor 94 is connected with the output terminal 95 of the filter network, which terminal is also connected through a lead 96 with the control grid 97 of the amplifier stage 58. The cathode 99 is likewise connected to ground through an unbypassed cathode resistor 100.

It will be noted that the signal input lead 87 is connected with a signal input terminal 101 next adjacent to the feedback output terminal 95 of the network and that the anode or feedback input terminal 93 is coupled to the signal output terminal 104 next adjacent thereto in the network, as in the case of the preceding stage.

The signal output tube of the amplifying channel 48 is a detector 105 comprising a pair of parallel connected anodes 106 and a cathode 107, the latter being connected through a lead 108 and relay contacts 109 and 110 with ground 111. This provides a connection with the ground terminal of the first grounded resistor 90 of the network 88, which is the detector output impedance, as well as one of the coupling elements of the network.

The output circuit 46 of the amplifying channel 48 is the output anode circuit of an amplifier included in the tube 105 with the rectifier, and having the cathode 107 in common therewith. The output anode 115 is connected with the output circuit 46 and the relay winding 45 and receives energy from a positive anode potential supply lead indicated at 116.

The control grid of the amplifier is indicated at 117 and is connected with the output impedance of the detector through a lead 118 and the terminal 104. A filter comprising a series resistor 120 and a bypass capacitor 121 is provided in the connection to prevent the application to the grid 117 of any signal component and only the D.-C. component of the rectified subaudible signal frequency.

The amplifying channel 48 thus comprises a two stage resistance-capacity network in circuit with each of two amplifiers cascade-connected between the control signal supply terminal 42 and the rectifier or detector 105-106. Each network includes a sufficient number of successive elements with the proper resistance and capacity values to effect an 180° phase shift between the input or anode end of each network and the output or grid end thereof. In other words, each network, together with its associated amplifier tube, is regenerative at a frequency which gives 180° phase shift through the network between anode and control grid of the stage, and at this frequency the network circuit becomes sharply selective. In the present example, this frequency for the channel 48 is chosen at 24 cycles per second which is one of the control signal frequencies. The large negative feedback provided by the unbypassed cathode resistors 67 and 100 prevent the amplifier network from oscillating while maintaining the selectivity provided by the regeneration effect.

The cathodes of the signal receiving portion of the system and of the amplifier and detector stages of the 24 cycle control frequency amplifying

channel 48 are of the indirectly heated type. For the purpose of making the understanding of the circuit more clear, the filaments or heaters are shown in a separate series heater or filament circuit indicated at 125. In this circuit the 24 cycle amplifier filaments are indicated at 126 and the receiver filaments at 127, being connected with the grounded side 128 of power supply circuit terminals 129 for alternating or direct current. The circuit 125 also includes a current limiting resistor 130 and the cathode heater or filament 131 of a power rectifier tube 132 which is connected with the high potential side of the supply terminals 129 through a lead 133 and a power or operating switch indicated at 134. A pilot lamp 135 for the receiver is connected across a portion of the rectifier filament 131. The cathode 136 of the rectifier 132 is also connected with the high potential supply lead 133, while the anode 137 is connected through a suitable filter 138 with the positive anode supply lead 116 for the receiver and the amplifiers. The various electrode connections with this lead for the various tubes in the system have been omitted for the sake of simplifying the drawing.

The power supply and cathode heater circuit thus far described is of the so-called A. C.-D. C. type which permits the supply circuit terminals 129 to be connected with any suitable alternating or direct current supply source of the proper voltage.

The amplifying channel 49 is essentially the same as the amplifying channel 48 except that it is made responsive to a different subaudible control frequency, such as 36 cycles, for example, and comprises a first stage amplifier 140 provided with a 180° phase shift network 141 between the anode circuit 142 and the grid circuit 143 which causes the amplifier to be regenerative at 36 cycles. The amplifier is stabilized by the inverse or degenerative feedback introduced through the unbypassed cathode resistor 144.

Control signals from the terminal 42 of the receiving system are applied to the signal input terminal 145 of the network adjacent to the grid terminal 146 and are derived from the amplifier stage through the terminal 147 adjacent to the anode or feedback input terminal 148. The output coupling connection is provided through a lead 150 which is connected with a signal input terminal 151 for the regenerative coupling network 152 of the succeeding or second stage amplifier 153. This amplifier is connected in the same manner as the first stage and as in the amplifying channel 48.

The control signal output terminal is indicated at 154 and is connected with a control grid 155 of a detector 156 which forms the terminal tube of the amplifying channel 49, corresponding to the detector 105 of the channel 48. In this case, the detector is of the triode type having a cathode resistor 157 coupled to the control grid 158 of a direct current amplifier 159 through a filter resistor 160 for which a filter capacitor 161 is provided, thereby to apply to the grid 158 only the direct current component of the rectified subaudible control frequency signal transmitted through the channel 49. The amplifier output circuit is connected with the lead 47 so that output current variations serve to control the relay 45 along or in parallel with the control provided through the output circuit 46 of the channel 48.

The heaters or filaments for the tubes 140, 153, 156 and 159 of the 36 cycle channel amplifier are indicated at 165 and are connected on one side

with a contact 166 of the relay 43 and on the other side with the high potential supply lead 133 of the power supply circuit through a lead 167, the cathode heater 40 of the output amplifier stage 30 and a current limiting resistor 168. When the relay 45 is deenergized the contact 110 is caused to close with the contact 166 thereby connecting the heater circuit for the amplifier channel 49 with ground and the grounded lead 128 of the power supply, thus energizing the heaters and the heater 40 of the power amplifier 30.

The operation of the system is as follows: With the switch 134 closed, the receiving system is energized, anode potential being applied to the various screen grid and anode circuits of the amplifier channels 48 and 49, from the rectifier 132, as its heater and the receiver and 24 cycle amplifier heaters 126 and 127 are energized. Assuming the relay contacts 109 and 110 to be closed initially to energize the relay winding 45, in the absence of a received signal, the grid 117 of the detector 105 in the amplifier channel 48 is substantially without bias and the anode current through the circuit 46 and the relay operating winding 45 is maximum, causing the relay contacts to be held closed in the position shown.

When a 24 cycle signal is received on a carrier wave to which the receiver is tuned, the 24 cycle signal is applied to both amplifier channels and is amplified in the channel 48 causing a negative bias to be applied to the grid 117 from the rectifier output resistor 90 in the input end of the network 88 and a reduction in the anode current through the circuit 46 and the winding 45, thereby causing the relay contacts 109 and 110 to open rendering tube 105 inoperative, and permitting the contact 110 to close with the contact 166. This energizes the 36 cycle amplifying channel, that is, the cathode heating circuit, in the present example, which is then in readiness to receive and amplify a 36 cycle signal on the same carrier when the transmission of intelligence over the receiving system is completed. The receiver is put into operation by the heater 40 of the output stage 30 being energized along with the heaters of the 36 cycle amplifier and while energized, signals may be received, such as air-raid warnings or other intelligence as desired on the same or any carrier wave to which the receiver is tuned.

Upon completion of the reception desired, the receiver is deenergized or rendered inoperative to receive signals upon reception of a 36 cycle signal, which is sharply amplified in the amplifier 49 and causes the detector grid 155 to become more positive. The increase in anode current through the cathode resistor 157 causes a positive bias to be applied to the grid 158 thereby increasing the anode current through the circuit 47 and the relay winding 45 which moves the contacts into the position shown whereupon the current through the anode circuit 46 continues to hold the contacts 109 and 110 closed. Thus the system is again in readiness to receive a 24 cycle controlling signal, while the output is silenced since the 36 cycle amplifier and output amplifier cathode heaters are deenergized. A considerable saving in operating current is provided by thus causing the 36 cycle amplifier heaters to be deenergized along with the power output heater 40.

By staggering the frequency of maximum response of the networks 88 and 89 and the networks 152 and 141 the resonant frequency of the signal selecting amplifiers may provide an overall

wider or broad band pass selectivity characteristic so that the system may readily respond to the control signals although the tuning at the receiver or at the transmitter may shift slightly.

By providing separate stages or a plurality of networks in the separate amplifying channels, a low value of equivalent selectivity with better discrimination against operation by noise or interference is provided than by the use of the customary tuned vibratory relay means.

Furthermore, as hereinbefore pointed out, the resistor-capacity networks are relatively simple and of low cost design while permitting the application of D.-C. operating potentials to the various electrodes, each circuit being independent of the other, and by utilizing a sufficient number of elements in the networks the same may be made regenerative at a frequency which gives 180° phase shift, which frequency is that for which the amplifier is tuned. Hence the highly regenerative circuit may be made sharply responsive to any desired signal or control frequency while being stabilized against oscillation by the degeneration introduced in each stage by the large cathode resistors without bypass.

I claim as my invention:

1. The combination with a radio signal receiving system, of a plurality of sub-audible control frequency amplifying and detecting channels each including a detector and a preceding amplifier stage having a control grid circuit and an anode circuit, a resistance-capacity interstage coupling network connected between said grid and anode circuits in each channel providing a 180° phase shift at predetermined differing sub-audible control frequencies, whereby said control channels are regenerative and selective at said frequencies, a stand-by signal receiving portion including a signal detector, means for deriving said sub-audible signals from said last named detector, means for applying said signals at said sub-audible frequencies to said control channels, and means responsive to the detector output of each amplifier channel for controlling a condition of operation of said receiving system.

2. The combination with a radio signal receiving system, of a plurality of sub-audible control frequency amplifying and detecting channels each including a detector and a preceding amplifier stage having a control grid circuit and an anode circuit, a resistance-capacity interstage coupling network connected between said grid and anode circuits in each channel providing a 180° phase shift at predetermined differing sub-audible control frequencies, whereby said control channels are regenerative and selective at said frequencies, a stand-by signal receiving portion including a signal detector, means for deriving said sub-audible signals from said last named detector, means for applying said signals at said sub-audible frequencies to said control channels, and means connected with the detector output of each amplifier channel for rendering said system operative for normal intelligence transmission in response to one sub-audible signal and for rendering said system inoperative for normal intelligence transmission in response to the other of said sub-audible signals.

3. In a radio signal receiving system, a plurality of control channels each including an amplifier tube having a control grid circuit and an anode circuit, a resistance-capacity network connected between said grid and anode circuits providing regenerative and selective response therein at different subaudible control frequencies, means

comprising a stand-by signal receiving channel for applying to said amplifiers modulated signals including said frequencies, a detector connected with the output of each of said amplifiers, and means responsive to the detector output of each amplifier channel for controlling a different condition of operation of said receiving system.

4. The combination with a signal receiving system, of means for deriving therefrom sub-audible frequency control signals, a pair of parallel connected amplifiers each comprising an amplifier stage having a control grid circuit and an output anode circuit, a resistance-capacity interstage coupling network connected between said circuits in each of said amplifiers providing successive resistance and capacity elements to effect a 180° phase shift between said circuits at predetermined sub-audible control frequencies, whereby said amplifiers are regenerative and selective at said frequencies, means in each of said amplifiers for establishing a predetermined degree of inverse stabilizing feedback, whereby said amplifiers are selectively responsive to a modulated signal wave when said wave is modulated by predetermined sub-audible control signals preceding and following intelligence transmission thereon, means for applying said control signals at said frequencies to said amplifiers, and means for deriving from said amplifiers a control current which changes in magnitude and direction in response to each of said control signals.

5. The combination with a signal receiving system, of a circuit for energizing at least a portion of said receiving system, relay means controlling said circuit, a pair of amplifying channels each having an output circuit connected with said relay means to apply operating current thereto, and including an amplifier stage having a control grid circuit and an output anode circuit, a resistance-capacity interstage coupling network connected between said circuits providing a 180° phase shift at predetermined sub-audible control frequencies, whereby said amplifier stages are regenerative at said frequencies, means in said amplifier stages for establishing a predetermined degree of inverse stabilizing feedback, whereby said

amplifier channels are selectively responsive to a modulated signal wave when said wave is modulated by predetermined sub-audible control signals preceding and following intelligence transmission thereon for controlling said relay means, means for applying said control signals at said frequencies to said amplifying channels, and means for deriving from said amplifying channels a control current which changes in magnitude and direction in response to each of said control signals.

6. The combination with a signal receiving system, of means for rendering said system responsive to a plurality of sub-audible control signals to reproduce intelligence transmitted on a received carrier wave and for rendering said system non-responsive in the reproduction of intelligence selectively, said means including a circuit for energizing at least a portion of said receiving system through which signals are translated, a relay controlling said circuit, a pair of amplifying channels each having an output circuit connected with said relay to apply operating current thereto, and including an amplifier stage having a control grid circuit and an output anode circuit, a resistance-capacity interstage coupling network connected between said circuits in each of said amplifier channels providing successive resistance and capacity elements to effect a 180° phase shift between said circuits at predetermined sub-audible control frequencies, whereby said amplifier channels are regenerative at said frequencies, means in each of said amplifier channels for establishing a predetermined degree of inverse stabilizing feedback, whereby said amplifier channels are selectively responsive to a modulated signal wave when said wave is modulated by predetermined sub-audible control signals preceding and following intelligence transmission thereon for controlling said relay, means for applying said control signals at said frequencies to said amplifier channels, and means for deriving from said amplifier channels a control current which changes in magnitude and direction in response to each of said control signals.

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