July 22, 1947. C. E. ATKINS 2,424,216

CONTROL SYSTEM FOR RADIO RECEIVERS

Filed Jan. 24, 1945 2 Sheets-Sheet 1

Fig. 1.

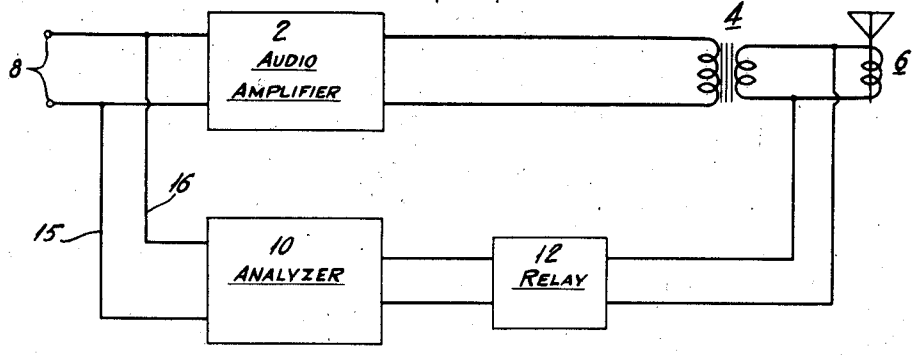


Fig. 2.

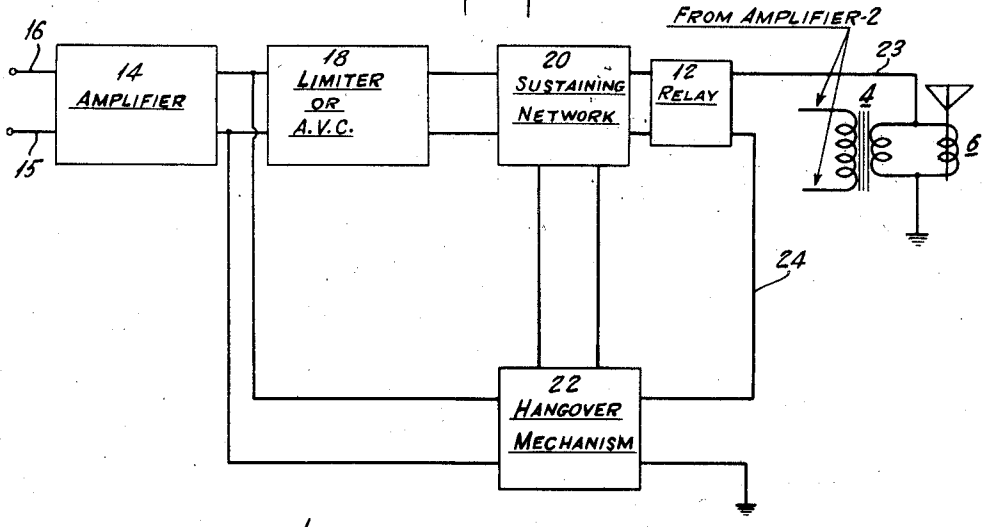
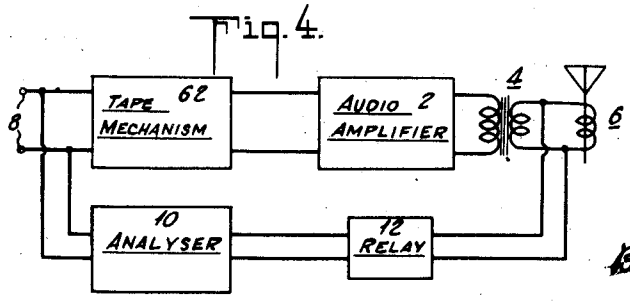


Fig. 4.



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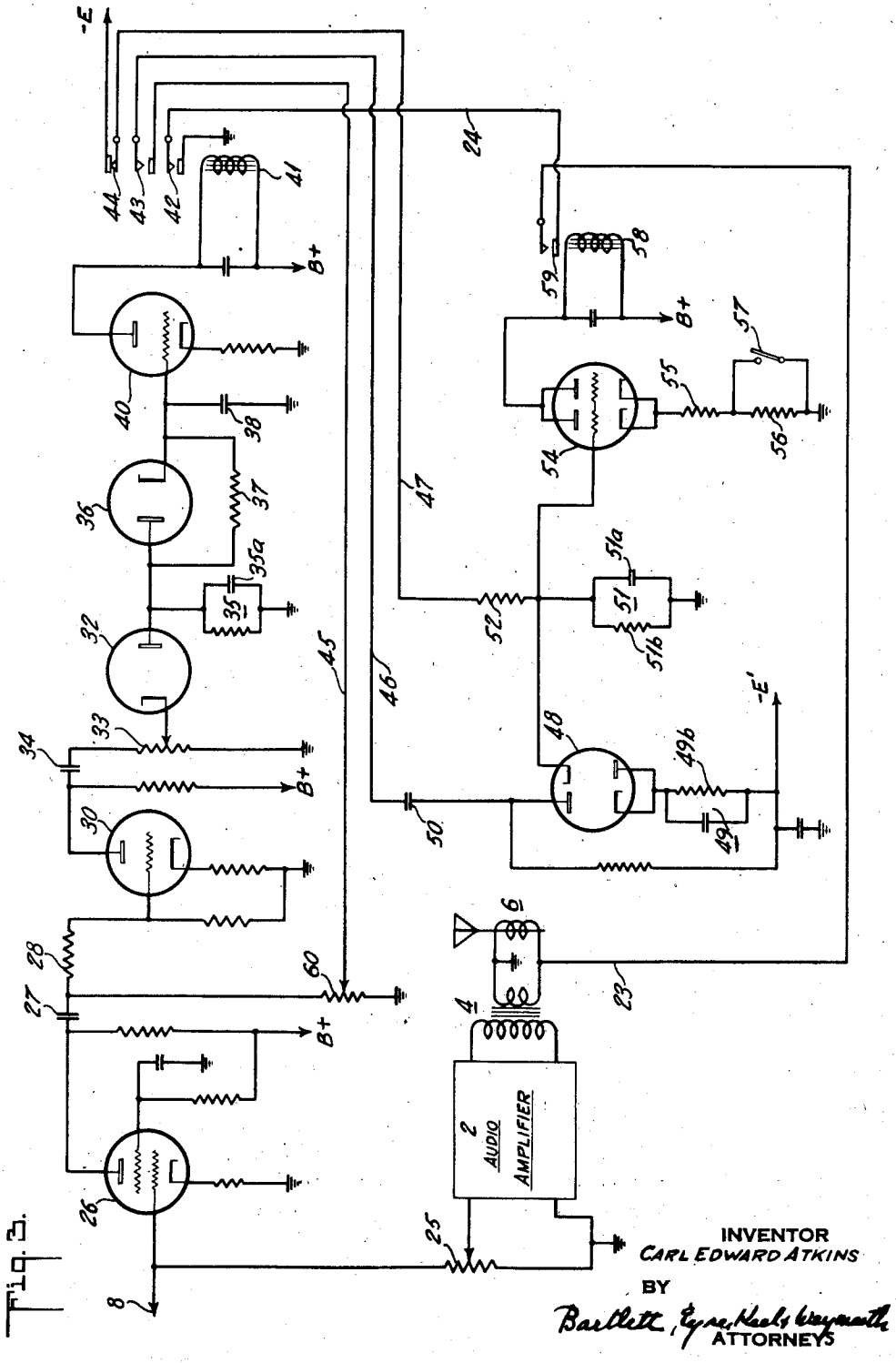


Fig. 2.

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CONTROL SYSTEM FOR RADIO RECEIVERS

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13 Claims. (Cl. 179—1)

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My present invention relates to radio receivers and comprises a control for the audio frequency portions thereof which is sensitive to the type of program being received and operative to control the audio output accordingly. The control system of the invention may be employed, for example, to suppress the speech portions of a program or to reduce the volume thereof while letting the music come through in normal volume, or conversely to remove or reduce the music portions of the program while permitting normal reception of the speech. For example, in airplanes where the pilots must keep their receivers turned on in order to hear instructions, the steady hum or tone between the spoken instructions is tiring to the pilot's ears. With the system of the present invention the steady tone could be suppressed without impairment of the reception of the instructions. Instead of suppressing or reducing the volume of either the speech or music portions of the receiver output, the new control could be arranged to adjust automatically the tonality of the audio system of a receiver in response to the type of program being received so as to insure optimum tone quality and this adjustment could include a degree of muting of either the speech or music portions as desired.

There is a much greater difference in the ratio of peak energy to average energy in speech than in music; music energy having a degree of continuity in marked contrast to the intermittent character of speech energy. In accordance with the invention circuits sensitive to this characteristic difference between speech and music energy are provided and utilized for selection of the type of audio output desired.

A feature of the invention is the utilization of the signal energy for effecting the control.

Another feature of the invention is the provision of means for insuring sharp cut-off of either the speech or the music. Further features of the invention are the simplicity of the equipment required and the positive response thereof to changes in the type of received signal energy.

For a better understanding of the invention reference may be had to the accompanying drawings, of which

Fig. 1 is a block diagram explanatory of the control system;

Fig. 2 is a block diagram of the equipment comprising the control system;

Fig. 3 is a circuit drawing of a control system

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comprising a specific embodiment of the invention; and

Fig. 4 is a block diagram illustrating a modification.

In Fig. 1 the audio amplifier 2, output transformer 4 and speaker coil 6 represent part of a conventional radio receiving set, energy being fed to the amplifier 2 through terminals 8 connected to the detector or previous audio frequency stage of the receiver. In accordance with the invention energy is fed from terminals 8 to an "analyzer" 10. Analyzer 10 determines the relative continuity or discontinuity of the energy supplied thereto and serves to actuate a relay 12 so as to short or not short the speaker coil 6, depending on the controlling energy delivered from the analyzer. Thus the purpose of analyzer 10 is to determine whether speech energy or music energy is being delivered to the audio amplifier 2 and to operate the relay 12 accordingly. Relay 12 can be arranged to normally short the coil 6, opening its contacts when music energy, for example, is fed to analyzer 10 and keeping them closed when speech energy is present or, conversely, normally open contacts of relay 12 could be closed when speech energy is received. If speech, not music, were desired in the output of the speaker coil, the analyzer 10 and relay 12 would be arranged to short the speaker coil when music energy is delivered to analyzer 10 and amplifier 2. If part rather than complete suppression of either music or speech were desired relay 12, instead of shorting the speaker coil 6, could operate to open a shunt about a resistance of suitable value in the circuit of the voice coil. Other specific arrangements coming within the diagrammatic disclosure of Fig. 1 will occur to those skilled in the art.

Fig. 2, to which reference may now be had, is a block diagram of the apparatus comprising analyzer 10. As shown it includes an amplifier 14 to which energy is supplied through the leads 15 and 16, connected as shown in Fig. 1, to the input terminals 8, a limiter or automatic volume control 18 connected to the output terminals of amplifier 14, and delivering energy to a sustaining network 20 and a hangover mechanism 22 connected to the output terminals of amplifier 14 and to network 20. Relay 12, which may be a vacuum tube relay system, is actuated by direct current energy from sustaining network 20 and is provided with suitable contacts that connect and disconnect the line 23 leading from the ungrounded side of speaker coil 6 with line 24 which connects through suitable relay contacts in

hangover mechanism 22 to ground. Speaker coil 6 thus becomes shunted when contacts in relay 12 and in mechanism 22 are both closed. When contacts in either relay 12 or mechanism 22 are open, the speaker coil is not shorted and energy delivered through transformer 4 will actuate the coil 6 to produce acoustical energy.

In the operation of the above described system, energy delivered to sustaining network 29 from amplifier 14 is limited in limiter 18 so that speech and music energy are on a more or less equal footing with the peaks of the energy waves ironed out. The network then functions to produce a D. C. voltage, the magnitude and stability of which are functions of continuity of the audio energy applied to it. It is this D. C. potential that operates relay 12 on a "go" or "no go" basis. Hangover mechanism 22 receives energy directly from amplifier 14 and functions to carry the system along during musical soft passages. I have found that piano music, for instance, gives rise to very choppy operation unless the system is alive for a short while after each note. Mechanism 22 is thus essentially a probability device which improves the operation of the system.

In Fig. 3 is illustrated one specific embodiment of the invention diagrammatically indicated in Figs. 1 and 2. In Fig. 3 the audio amplifier 2 of a radio receiver is shown connected through a potentiometer 25 to terminal 8 for energization by the detector or other preceding stage of the receiver. The voice or speaker coil 6 is energized from amplifier 2 through transformer 4 unless lead 23 connected to the ungrounded side of the coil is grounded through the hangover and relay mechanisms as hereinafter described. An audio frequency amplifier, comprising the tube 26, has its control grid connected to terminal 8 and its plate connected through a condenser 27 and relatively large resistor 28 with the grid of a limiter tube 30. The output of tube 30 is rectified by a diode 32 having its cathode connected through a volume control 33 and condenser 34 with the anode of tube 30 and its anode connected to a load network 35 and to the anode of a second diode 36. A resistor 37 is bridged across diode 36 and these elements 36 and 37 together with a condenser 38 connected to the cathode of diode 36 comprise the sustaining network of Fig. 2. A triode 40 having its grid connected to the cathode of diode 36, a coil 41 in the output circuit of triode 40 and contacts 42, 43 and 44 controlled by coil 40 comprise the relay mechanism associated with the sustaining network. Network 35 must be designed to have a low D. C. resistance and a short time constant. I have found 100,000 ohms resistor with a .05 microfarad shunt condenser satisfactory. The resistor 37 through which condenser 38 is charged should be high, say from 2 to 20 megohms. It is voltage across condenser 38 that operates tube 40 and the rest of the relay mechanism. When the system is quiescent, that is, when no energy is being delivered to amplifier 26, tube 40 normally draws enough space current to energize coil 41 sufficiently to close contacts 42 and 43 and hold open contacts 44. In this position line 24 connecting the relay and hangover mechanisms is grounded, leads 45 and 46 are connected together for a purpose hereinafter described, and a lead 47 connected to the hangover mechanism is disconnected at contacts 44 from a source of negative potential indicated by —E in the drawing.

The hangover mechanism includes a double diode 48 having one anode and one cathode tied together and connected through a network 49 with a source of negative potential indicated as —E', its other anode connected through a condenser 50 with line 46, a network 51 grounded at one end and connected at its other end to the other cathode of double diode 48, and, through resistor 52 to line 47, and a double triode 54 having its control grids connected to network 51, its cathodes connected through series resistors 55 and 56 to ground and having a coil 58 in its output circuit. Resistor 56 when the control system is operating is shunted by a switch 57. Coil 58 when energized closes contacts 59 connecting lines 23 and 24. Tube 54, like tube 40, normally draws enough space current to energize coil 58 sufficiently to keep contacts 59 closed. Thus when the system is quiescent line 23 leading from the voice coil 6 is grounded through contacts 59, line 24 and contacts 42. When audio frequency energy is applied through amplifier 26, and limiter 30, it is rectified by diode 32 and a D. C. voltage is produced across network 35. The stability of this D. C. voltage is a function of audio frequency continuity while the magnitude thereof depends upon the design of limiter 30 and the setting of volume control 33. This D. C. voltage across network 35 is negative with respect to ground and charges condenser 38 through resistor 37 at a relatively low rate. The time constant of resistor 37—condenser 38 is such that a negative potential sufficient to block tube 40 and deenergize coil 41 is not reached except when the voltage across network 35 is relatively sustained. As the voltage across network 35 drops nearly to zero between syllables, any charge accumulated on the condenser 38 leaks off rapidly through diode 36 and the relatively low resistance of network 35. The condenser 35*a* of network 35 prevents the discharge of condenser 38 during every cycle. Thus the sustaining network is in effect a device which charges slowly and discharges rapidly. During a musical passage of any duration sufficient voltage becomes available to block tube 40 and to thereby keep contacts 42 open so that the music may be heard. Sustained vocalisms, such as singing, operate in the same manner.

In order to obtain a certain hangover effect, that is, to bridge relatively short periods of silence during musical programs, line 47 is connected, when tube 40 is blocked, to a source of negative voltage through contacts 44. This charges the condenser 51*a* (of say 15 microfarads) of network 51 through resistor 52 (of say 2 megohms). The potential across condenser 51*a* is negative and therefore blocks tube 54 and thereby causes coil 58 to become deenergized following deenergization of coil 41. When there is a lag in the musical passage sufficient to cause energization of coil 41, and opening of contacts 44, the charge on condenser 51*a* leaks off slowly through resistor 51*b* of network 51. This resistance is high enough, say 10 megohms, to cause coil 58 to remain deenergized for an appreciable time after energization of coil 41. Any soft music will thus be heard, as the contacts 59 are kept open. At the same time that coil 41 becomes energized, one anode of double diode 48 becomes connected through the condenser 50, line 46, contacts 43 and line 45 to the source of audio frequency energy through a volume control 60. This audio frequency energy develops a positive voltage across resistor 49*b* of network 49 which voltage ordinarily is insufficient to render conducting that

part of the diode connected with network **51**. When, however, a large signal is applied to diode **48** from volume control **60**, the potential across resistor **49***b* is large enough to counteract the negative polarizing bias on the other terminals of the double diode so that condenser **51***a* can discharge rapidly through the diode, resistor **49***b* which is about one megohm, and the internal resistance of the source E' of negative voltage. The system would, of course, be adjusted so that a soft musical passage would not overcome the biasing voltage on the diode **48**, but a sudden burst of speech would cause condenser **51***a* to become discharged, re-energizing coil **58** and muting the speech.

When it is desired to hear both music and speech, switch **57** is opened, to place resistor **56** in series with resistor **55**, thus inserting sufficient resistance in the cathode circuit of the tube **54** to prevent the drawing of sufficient space current to energize coil **58**.

Although the system of Fig. 3 operates efficiently to delete substantially all of the speech parts of a program, there will be a brief period of silence at the beginning of a musical sequence while the sustaining condenser **38** is being charged and, conversely, at the beginning of a speech program following a musical sequence, a few words may be heard due to operation of the hang-over mechanism. These minor shortcomings of the system of Fig. 3 can be overcome, however, by providing, as indicated in Fig. 4, a delay mechanism, as for example, a magnetic tape device **62** between the audio amplifier **2** and the preceding stage of the receiver. The audio frequency signal energy is then fed in parallel to the analyzer **10** and tape mechanism **62**. With this arrangement the time delay of the mechanism **62** is made equal to the charging period of the sustaining condenser for the analyzer and also equal to the discharge period of the condenser of the hang-over mechanism. Thus the circuits of the analyzer are given the opportunity to perform their function before the corresponding signal energy appears at the portals of the voice coil and hence the cut-off of the speech portions can be effected at the exact moment desired.

The invention has now been described in connection with one specific embodiment and one refinement thereof. Obviously various changes could be made in the particular circuits disclosed and various parts could be omitted without departing from the spirit of the invention as defined in the accompanying claims. For example, although the analyzer has been shown as including an amplifier, such amplifier while useful is not essential to the operation of the system. Also that part of the hangover mechanism comprising the means for rapid discharge of the condenser **51***a* when sudden bursts of energy are received may be omitted if desired, and would, of course, be omitted when the refinement of Fig. 4 is employed.

I claim:

1. The combination with a radio receiver having an audio amplifier and a reproducing device, of a system for controlling the output of said reproducing device in accordance with the audio frequency signal energy fed to said amplifier, said system including a sustaining network for converting audio frequency signal energy into a direct current control voltage the stability of which is a function of the continuation of the signal energy, a relay responsive to said direct current control voltage and operative to control said reproducing device, said relay operating upon a reduction of said direct current control voltage to suppress the operation of said reproducing device and a mechanism associated with said relay and with said sustaining device for delaying the suppression of said reproducing device upon operation of said relay.

2. A control system for radio receivers having an audio frequency amplifier and a reproducing device comprising an analyzer responsive to the degree of continuity of the signal energy fed to the amplifier, means controlled by said analyzer for controlling the operation of the reproducing device and recording means for storing signal energy for delaying the application of signal energy to the amplifier for a period of time equal to the time required by said analyzer for effectuating control of the reproducing device.

3. The combination with a radio receiver having an audio frequency amplifier and a reproducing device of a system for controlling the output of said device in accordance with the audio frequency signal energy fed to said amplifier, said system including a mechanism for delaying the delivery of signal energy to the amplifier, a relay for controlling the reproducing device, a condenser controlling said relay, a network responsive to the audio frequency signal energy for gradually charging said condenser when the signal energy is continuous as in music and for rapidly discharging said condenser when the signal energy is discontinuous as in speech, and means operative when said condenser discharges for delaying the control of the reproducing device by said relay for a time equal to the time delay interposed by said mechanism and to the charging time of said condenser.

4. The combination with a radio receiver having an audio frequency amplifier and a reproducing device of a control system for controlling the output of the reproducer in accordance with the type of signal energy fed to the amplifier, said system including a sustaining network for discriminating between speech and music energy, a relay controlled by said network and operative to control the reproducing device and a limiter device connected to receive the signal energy and serving to suppress the peaks of the signal energy waves prior to delivery to said sustaining network.

5. The combination with a radio receiver having an audio frequency amplifier and a reproducing device of a control system for controlling the output of the reproducer in accordance with the type of signal energy fed to the amplifier, said system including a sustaining network for discriminating between speech and music energy, a relay controlled by said network and operative to control the reproducing device and a limiter device connected to receive the signal energy and serving to suppress the peaks of the signal energy waves prior to delivery to said sustaining network, said sustaining network including an element having a slow rate of charge and a rapid rate of discharge, said element charging when the signal energy is continuous as in music and discharging when the energy is discontinuous as in speech and wherein said control system includes means associated with said network for delaying the control of the reproducing device by said network upon discharge of said element.

6. The combination with a radio receiver having an audio frequency amplifier and a reproducing device of a control system for suppressing the

output of the reproducing device when the signal energy delivered to the amplifier is speech energy, said system including a sustaining network having an element which charges slowly when the signal energy is music energy and discharges rapidly when the signal energy is speech energy and operates when said element discharges to suppress the reproducing device, means associated with said network for delaying suppression of the reproducing device upon discharge of said element and a mechanism associated with said delay means for rendering said means ineffective to delay the suppression of the reproducing device when a sudden burst of energy is applied to said network.

7. The combination with a radio receiver having an audio frequency amplifier and a reproducing device of a control system for suppressing the output of the reproducing device when the signal energy delivered to the amplifier is speech energy, said system including a sustaining network having an element which charges slowly when the signal energy is music energy and discharges rapidly when the signal energy is speech energy and operates when said element discharges to suppress the reproducing device, means associated with said network for delaying suppression of the reproducing device upon discharge of said element, the period of delay imposed by said last mentioned means is equal to the charging time of said element, and means for delaying the delivery of signal energy to the amplifier for a period of time equal to the charging time of said element whereby the suppression of the reproducing device will coincide exactly with the termination of a musical passage.

8. A control system for radio receivers having a reproducing device comprising in combination a half-wave rectifier for rectifying audio frequency signal energy, a resistor of relatively high value and a capacity connected in series for gradual charging of the capacity through said resistor by the output from said rectifier, a diode bridging said resistor for rapid discharge of said capacity when the output of said rectifier is reduced, and a relay controlled by said capacity and operative to control the reproducing device.

9. A control system for radio receivers having a reproducing device comprising in combination a half-wave rectifier for rectifying audio frequency signal energy, a resistor of relatively high value and a capacity connected in series for gradual charging of the capacity through said resistor by the output from said rectifier, a diode bridging said resistor for rapid discharge of said capacity when the output of said rectifier is reduced, and a relay controlled by said capacity and operative to control the reproducing device, and including a limiter for suppressing the peaks of the signal energy waves prior to rectification by said rectifier.

10. A control system for radio receivers having a reproducing device comprising in combination a half-wave rectifier for rectifying audio frequency signal energy, a resistor of relatively high value and a capacity connected in series for gradual charging of the capacity through said resistor by the output from said rectifier, a

diode bridging said resistor for rapid discharge of said capacity when the output of said rectifier is reduced, and a relay controlled by said capacity and operative to control the reproducing device, and including means associated with said relay for interposing a delay between the control of the reproducing device and the operation of the relay due to discharge of said capacity.

11. A control system for radio receivers having a reproducing device comprising in combination a half-wave rectifier for rectifying audio frequency signal energy, a resistor of relatively high value and a capacity connected in series for gradual charging of the capacity through said resistor by the output from said rectifier, a diode bridging said resistor for rapid discharge of said capacity when the output of said rectifier is reduced, and a relay controlled by said capacity and operative to control the reproducing device, and including means associated with said relay for interposing a delay between the control of the reproducing device and the operation of the relay due to discharge of said capacity and including means for delaying the delivery of signal energy to the reproducing device for a period of time equal to the charging time of said capacity and to the delay period introduced by said first mentioned delay means.

12. A control system for radio receivers having a reproducing device comprising in combination a half-wave rectifier for rectifying audio frequency signal energy, a resistor of relatively high value and a capacity connected in series for gradual charging of the capacity through said resistor by the ouput from said rectifier, a diode bridging said resistor for rapid discharge of said capacity when the output of said rectifier is reduced, and a relay controlled by said capacity and operative to control the reproducing device, and including means associated with said relay for interposing a delay between the control of the reproducing device and the operation of the relay due to discharge of said capacity and including means responsive to the audio frequency signal energy to render said delay means inoperative when the magnitude of signal energy exceeds a predetermined value.

13. A control system for radio receivers having a reproducing device comprising an analyzer for discriminating between speech and music energy, means controlled by said analyzer for controlling the operation of the repdoducing device in accordance with the type of audio frequency signal energy as determined by said analyzer, and means for delaying the application of signal energy to the reproducing device for a period of time equal to that required by said analyzer for discrimination of the energy and for effectuating control of the reproducer.

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REFERENCES CITED

The following references are of record in the file of this patent:

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