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FREQUENCY RESPONSIVE CONTROL SYSTEM

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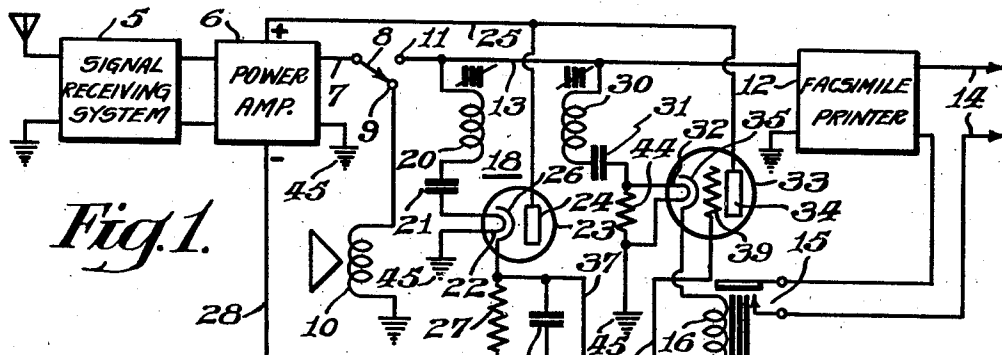


Fig. 1.

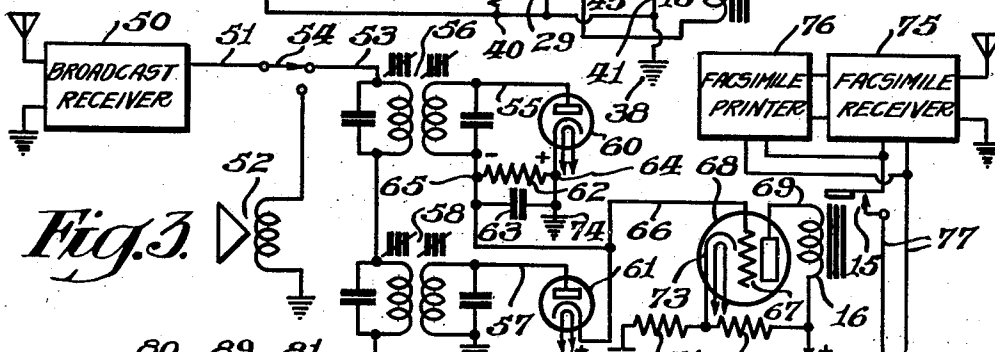


Fig. 3.

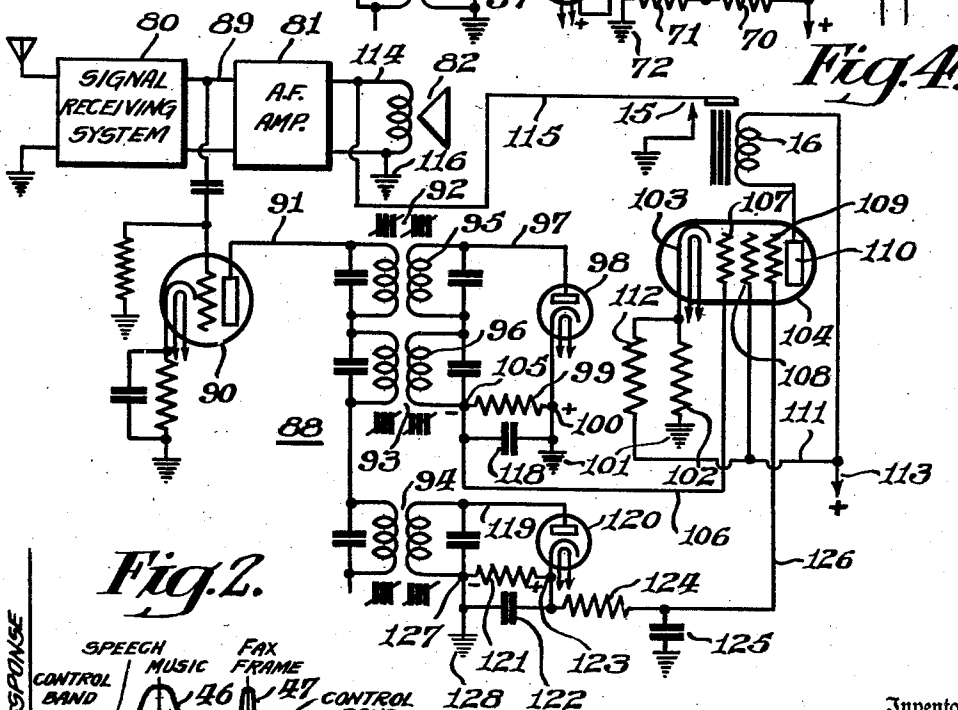


Fig. 4.

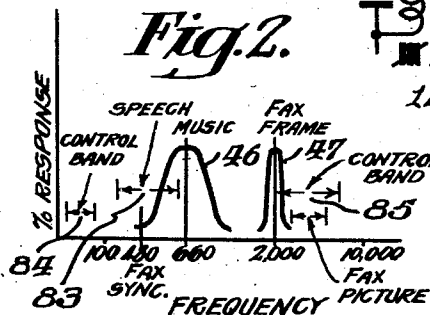


Fig. 2.

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FREQUENCY RESPONSIVE CONTROL SYSTEM

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8 Claims. (Cl. 178-5.6)

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This invention relates to frequency-responsive control systems, and has for its object to provide an improved frequency-responsive control system whereby a device or circuit may be controlled in some predetermined manner, actuated or prevented from functioning, in response to one or more frequency components of a received radio signal without being responsive to said components when received with other signals or components of the same signal.

It is also an object of this invention to provide an improved frequency-responsive control system in connection with a radio signal receiving system for effecting differing control functions selectively in response to signals at frequencies contained within a predetermined band of frequencies to which the signal receiving system is responsive.

It is a further object of this invention to provide a radio signal receiving system having a control function responsive to predetermined audio frequency signals in relatively narrow bands while preventing the occurrence of the control function in the presence of wider range audio frequency signals including said bands. In accordance with the invention, audio frequency signals in the frequency bands within which the energy of speech or music is maximum may be adapted to control a condition of operation of the receiving system, such as the signal output to a loudspeaker, or to control associated apparatus, such as a facsimile printer or a facsimile receiving system, without interfering with a normal function such as the reception and reproduction of broadcast programs, including music and speech, covering the full audio frequency band within which the control frequency or frequency bands are included.

It is also an object of this invention to provide a control system for operating a relay device in response to intermittent signals at a predetermined audio frequency or in a predetermined band of audio frequencies contained within the band of audio frequency signals inherent in music, and for preventing operation of said device in response to a wider band of audio frequencies including said intermittent signal frequencies.

Further, in accordance with the invention, a frequency-responsive control system is provided in connection with the audio frequency channel of a radio signal receiving system, for deriving an audio frequency signal or band of signals for blocking the control system, and another audio frequency signal or band of signals for operating the control system. Either or both signals may

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be rectified to provide suitable control potentials which, when applied to the control system, prevent the latter from operating or responding when a blocking signal is being received, while the system is operative in response to a control signal in the absence of the blocking signal. The operating signal may be an intermittent signal such as a facsimile framing signal or it may be the band of signal frequencies in which the maximum energy of speech is provided.

The invention will 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.

15 In the drawing,

Figure 1 is a schematic circuit diagram of a frequency-responsive control system embodying the invention as applied to a radio signal receiving system and recording apparatus,

20 Figure 2 is a graph showing curves illustrative of operating characteristics of the circuit of Figure 1,

25 Figure 3 is a further schematic circuit diagram of a modification of the control system of Figure 1, and

Figure 4 is a schematic circuit diagram of a frequency-responsive control system responsive to speech and embodying the invention in its application to a signal receiving system.

30 Referring to Figure 1, any suitable signal receiving system or signal source represented by the rectangle 5, for producing audio frequency signals, is connected to an audio frequency amplifying channel including a power amplifier 6 from which output signals are derived through an output circuit 7. A selector switch 8 in the output circuit provides a connection with a terminal 9 for energizing a suitable output device, such as a loudspeaker 10, and an alternative connection 40 with a contact 11 for supplying the audio frequency output to any suitable utilization apparatus such as a recorder or facsimile printer 12 through a circuit indicated at 13.

45 The facsimile printer is supplied with operating current from supply means represented by the circuit 14, under control of a suitable relay device comprising contacts 15 and an operating winding or coil 16 which is placed under control of the audio frequency signal currents in the circuit 13 through a frequency-responsive control system 18.

50 The control system or channel 18 comprises two tuned circuits, one of which is responsive to a blocking frequency contained within a wider

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frequency band, such as a band of audio frequency signals inherent to music.

The second tuned circuit is responsive to a control or operating frequency also within the audio frequency range, which frequency is characteristic of a signal applied to a controlled apparatus, such as the facsimile printer 12. In the present example, this is the facsimile framing signal which comprises intermittent pulses. It may, however, be any suitable operating signal providing operation or control of the relay device at the output end of the control channel. The blocking signal prevents the operation of the relay device whether the control signal is present or not.

In the present example, the first tuned circuit, connected with the audio frequency output circuit 13, comprises a tuning inductance 20, a tuning capacitor 21 and a current-responsive element 22 connected in series. The last is the heater or filament of a rectifier tube 23 having an anode 24 connected with a positive potential supply lead 25 from the power amplifier 6 or other suitable source, and having a cathode 26 connected through an output impedance or resistor 27 with a negative power supply lead 28 from the same source. The resistor 27 is provided with a shunt bypass capacitor 29.

The second tuned circuit, also connected with the audio frequency output circuit 13, comprises a tuning inductance 30, a series tuning capacitor 31 and a current-responsive device 32 which is the heater or filament of an amplifier tube 33. The last is provided with an anode electrode 34, connected with the positive supply lead 25, and a cathode 35, connected through the operating winding 16 of the relay and the resistor 27 by way of a lead 37 to the negative side of the supply circuit 28. The negative supply lead is also connected to ground or chassis as indicated at 38.

The control grid 39 of the amplifier tube 33 is connected to ground or to the negative terminal 40 of the resistor 27 through a grid lead 41. The filament 32 may be provided with a shunt resistor 44 for limiting the current flow there-through. Both control circuits 20-21-22 and the circuit 30-31-32 are connected back to the power amplifier or audio frequency source through ground or chassis connections indicated at 45.

The operation is as follows: A radio signal is selected, amplified and detected in the system 5 in the usual manner and is further amplified in the power amplifier 6, the audio frequency output of which may be applied through the switch 8-9 to the loudspeaker 10 for normal broadcast reception.

The audio frequency output may be applied to the output circuit 13 through the switch connection 8-11, from which it is supplied to the apparatus 12 and to the two control circuits in parallel. In the present example, the first control circuit is tuned to the midfrequency of the peak energy content of music which may be assumed to be of the order of 660 cycles, while the second control circuit is tuned sharply to the operating signal for the control system which is chosen as the facsimile framing pulse frequency of 2000 cycles.

When the control frequency is present, that is, when the facsimile signal is received, the circuit 30-31-32 responds to the 2000-cycle signal, causing the series circuit to resonate at that frequency and producing sufficient current to heat the filament 32 of the control amplifier 33. Plate current then flows from the anode 34 to the

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cathode 35 and thence through the operating winding 16 of the relay device causing the contacts 15 to close, thereby energizing the facsimile printer 12 and permitting operation thereof in response to the received facsimile signal.

If music is present with or without the strong facsimile framing pulse, the circuit 20-21-22 responds to the peak energy content thereof, causing the heater 22 to be energized and permitting current to flow from the anode 24 to the cathode 26 of the rectifier 23 and thence through the output resistor 27 which applies a strong negative bias between the cathode 35 and the grid 39 thereby cutting off the tube 33 so that, whether the facsimile signal is present or not, the relay device may not operate. Likewise, the control channel is blocked against operation in response to any 2000-cycle component present in the music received through the system.

With this arrangement, the receiving system may be energized and maintained in operation for facsimile reception without energizing the facsimile apparatus except when a facsimile signal is actually received. Thus the normal transmission of broadcast signals including signals in the range of the control frequency does not operate the system.

The operation of the system may further be understood with reference to Figure 2 showing a curve 46 representing the response of the circuit 20-21-22 to the peak energy content of music in the region of 660 cycles and a curve 47 representing the response of the circuit 30-31-32 to the facsimile framing impulses at 2000 cycles. The latter circuit is preferably sharper in its frequency response than the circuit 20-21-22 as indicated by the relative width of the two curves.

It will be noted in connection with Figure 2 that the facsimile signal also includes a facsimile picture signal in a frequency range above the framing signal and a facsimile synchronizing signal which is a steady signal of the order of 480 cycles which falls below the response range of the blocking circuit 20-21-22. The facsimile synchronizing signal does not block the control system when receiving facsimile signals since the blocking circuit is tuned above the facsimile synchronizing signal.

The thermal inertia of the heater 32 is such that it will maintain the tube 33 conducting during the reception of the 2000-cycle framing pulses, thereby maintaining the relay contacts closed for facsimile signal reception and recording. Also, during the reception of facsimile signals or when the tube 23 is in operation in response to normal broadcast signals, the thermal inertia of the filament 22, as well as the thermal inertia of the filament 33, is such that the system is not affected by static pulses.

In the present example, the main energy frequency of the normal broadcast or music is utilized as the blocking signal, while the operating or control signal is the facsimile framing pulse. Both signals are passed through series resonant circuits which cause a variation in a direct current to operate a relay device controlling apparatus which in this case is the facsimile printer. The latter receives its signal from the same audio frequency channel as the loudspeaker.

In another embodiment of the invention shown in Figure 3, a complete facsimile receiving equipment may be energized under control of the facsimile framing pulse signal of 2000 cycles, while the standard broadcast or music frequencies, also containing the 2000-cycle component, are pre-

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vented from operating the facsimile system, as in the circuit of Figure 1. The same blocking frequency of 660 cycles is utilized. However, rectification of the signals in the two branch circuits is provided to obtain biasing control of an amplifier which in turn controls the relay device.

Referring to Figure 3, the audio frequency output from a broadcast or other suitable receiver 50 is applied through an audio frequency output circuit 51 to either a loudspeaker 52 or a frequency-responsive control system having an input circuit 53, through a selector switch 54 which is shown in a position to apply the signals to the circuit 53.

The latter circuit includes a blocking signal circuit 55 coupled through a tuned transformer 56 to the circuit 53 and an operating or control signal circuit 57 coupled to the circuit 53 through a tuned coupling transformer 58. The transformer 56 is tuned broadly to 660 cycles in the present example, while the transformer 58 is tuned sharply to 2000 cycles. A rectifier 60 coupled to the circuit 55 and a rectifier 61 coupled to the circuit 57 are connected in opposition to a common output resistor 62 across which is connected a suitable bypass capacitor 63.

In response to normal broadcast signals including music, the circuit 55 is energized, causing the terminal 64 of the resistor 62 to become positive and the opposite terminal 65 to become negative. The latter terminal is connected through a lead 66 to the control grid 67 of a control amplifier 68, in the output circuit 69 of which is connected the relay operating winding 16.

Positive anode potential is also caused to flow through a bleeder resistor 70 and a bias resistor 71 to ground 73 to apply a negative bias between the grid 67 and the cathode 73 which is connected at a point between the two resistors 70 and 71. It will be noted that the terminal 64 of the resistor 62 is also connected to ground as indicated at 74.

Thus, a fixed negative biasing potential from the resistor 71 is applied to the grid 67 through a circuit which may be traced from the grid through the lead 66 to the terminal 65, thence through the resistor 62 to the terminal 64 and ground 74—72. In the absence of received signals, this biasing potential is such that the anode current is substantially cut off or maintained below a value sufficient to actuate the relay. In the presence of signals from the broadcast receiver in the broadcast range, or containing music, the biasing potential on the grid 67 is increased by the amount of the voltage which appears across the resistor 62 as a result of rectification, mainly of the 660-cycle band, applied to the rectifier 60 from the transformer 56.

If, during the reception of broadcast signals, the 2000-cycle facsimile signal is received, it passes through the circuit 57 by way of the sharply tuned transformer 57 and is rectified in the rectifier 61. The rectified signal component therefrom is in opposition to that provided from the rectifier 60 and may reduce the negative biasing potential on the grid 67. However, the fixed bias 71 is such that it maintains the tube 68 biased off or below an anode current value sufficient to operate the relay.

In the absence of broadcast signals and in the presence of a received facsimile signal or other controlling signal to which transformer 58 is tuned, the rectifier 61 delivers a positive potential on the grid 67 which may have a value sufficient to overcome the negative bias from the source 71

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and to permit the anode current to increase through the circuit 69 to the relaying value for the relay winding 16, thereby causing the contacts 15 to close, and energizing apparatus controlled thereby which may, in the present example, consist of a facsimile receiver 75 and a facsimile printer 76 energized through the contacts 15 from a power supply line 77. In the present example, it will be seen that two control circuits are employed in the control system, one responsive to a control frequency and the other responsive to a blocking signal. With this arrangement, as in the circuit of Figure 1, the controlled apparatus is prevented from operating in response to signals in the audio frequency range, although the control frequency is included in that range. Normally, a blocking frequency band is selected which provides maximum energy in the normally received signal range.

In the present example, the time constant of the circuit is established by the diode output resistor 62 and shunt capacity at 63, whereas in the circuit of Figure 1 the capacity at 29 and the resistor 27, in conjunction with the thermal heating time of the filaments, determine the time constant of that control circuit, both being such in the present example that the 2000-cycle framing pulses permit the relay 16—15 to operate without interruption, in the absence of the blocking signal.

The control system thus far described is particularly applicable for the control of facsimile receiving apparatus whereby whenever a radio transmitter broadcasts a facsimile signal on the wave length to which a receiver is tuned, the facsimile apparatus may operate to record the transmission without being put into operation by the normal broadcast transmission from the same station. Thus, the system may be placed in operation to stand by for facsimile signals, without response to normal broadcast transmission although the controlling frequency is included therein. A control system embodying the invention may, however, be provided with more than two control circuits and may be utilized to control apparatus other than facsimile apparatus. For example, it may be used to control a radio receiving system whereby transmission of signals of a certain character may be altered or cut off. One application of this arrangement is shown in Figure 4, to which attention is now directed.

A signal receiving system indicated at 80 is provided with an audio frequency amplifier 81 and a loudspeaker 82 coupled thereto, which may be cut off or muted in the presence of speech transmission alone as distinguished from the full transmission of music or other signals in the audio frequency band, thereby permitting the receiving system to respond only to music or other broadcast signals having substantially the full audio frequency range while being nonresponsive to transmission of speech alone.

Referring to Figure 2 along with Figure 4, the peak energy content of speech of occurs normally between 300 and 600 cycles, as indicated at 83. A control frequency band 84 below the normal speech band and a control frequency band 85 above the speech range may be chosen to provide two blocking signals for preventing operation of the control system when musical sounds are received in either or both control bands. Control bands of from 30 to 90 cycles, as at 84, and from 2000 to 6000 cycles, as at 85, are suitable for maintaining the control system blocked

and the sound output from the receiving system is maintained although signals in the speech range may be received therewith. Thus, music, or other audio frequency output including the speech range, is prevented from operating the control system except when the output from the receiving system is wholly speech, or signals of other predetermined frequency characteristic containing no components of appreciable magnitude in either of the blocking frequency bands.

Referring again to Figure 4, a three-circuit control channel 88 is coupled to the audio frequency circuit 89 of the receiving system through a suitable amplifier indicated by the single stage 90, the output circuit 91 of which is coupled to three-tuned coupling transformers indicated at 92, 93 and 94. The tuned secondary windings 95 and 96 of the transformers 92 and 93 are connected in series, aiding relation to a rectifier circuit 97 comprising a diode rectifier 98 and an output impedance 99 therefor. Transformers 92 and 93 are tuned respectively to the lower and the upper control bands or blocking signals which in the present example include the 30 to 90-cycle band for the transformer 92 and the 2000-6000 cycle band for the transformer 93.

With the arrangement shown, audio frequency signals received with a normal amplitude value in either or both of said bands are impressed upon the circuit 97 and the rectifier 98, resulting in a rectified direct current component across the resistor or output impedance 99. The polarity of the potential derived therefrom is indicated at the terminals of the resistor. The positive terminal 100 is connected to ground and through ground, and a source of biasing potential provided by a resistor 102, to the cathode 103 of an output amplifier 104 for the control channel.

The negative terminal 105 is connected through a lead 106 to one grid 107 of the amplifier, which is of the pentode type. The other elements of the amplifier include a screen grid 108, a second control grid 109 and an output anode 110. In the absence of signals, a fixed negative biasing potential is applied to the grid 107 from the source 102 which forms part of a bleeder connection 111-112 from a positive anode supply lead 113 to which the anode 110 is connected through the operating winding 16 of the relay.

For controlling the output of the receiving system and by way of example, the relay contacts 15 are connected across the loudspeaker output circuit 114 through a circuit lead 115 and ground 116, although the muting control may be effected in any other suitable manner.

The time constant of the rectifier circuit 97-98-99 is established by the resistor 99 and a shunt capacitor 118 whereby the circuit is readily responsive to musical frequencies in the ranges indicated, to provide additional negative biasing potential to that provided by the source 102, thereby to maintain the amplifier 104 substantially at cut-off and the relay 16 inoperative in the presence of music or signals covering the major portion of the audio frequency band.

The second control grid 109 is connected with the third control circuit comprising the tuned transformer 94 which is broadly responsive to signals in the peak energy range for speech, as between 300 and 600 cycles. Speech energy between these frequency limits is applied to a rectifier circuit 119 comprising a diode rectifier 120, and an output impedance or resistor 121 shunted by a suitable capacitor 122 for establishing a pre-

determined time constant for operation of the rectifier circuit.

The positive terminal 123 of the rectifier output impedance 121 is connected through a time constant delay network, comprising a series resistor 124 and a shunt capacitor 125 to a grid leak 126 connected with the other control grid 109. The negative terminal 127 is connected to ground 128 and thence to the cathode 103 through the fixed biasing potential source 102. Thus, in the presence of a strong frequency component in the major portion of the speech range, the biasing potential provided on the grid 109 from the source 102 is overcome or reduced by the potential across the impedance 121 as a result of rectifying the signals in that band through the circuit 119 and rectifier 120.

In the event that signals in the two blocking frequency ranges are absent, the increase in positive biasing potential on the second control grid 109 is sufficient to permit anode current to flow through the relay winding 16, thereby closing the contacts 15 and cutting off the sound output to the loudspeaker 82.

However, in the presence of music, the channel through the circuit 119 and the coupling transformer 94 is ineffective to cut off the loudspeaker because of the presence of signals in the circuit 97 which provides a negative biasing potential on the first control grid sufficient to cut off the tube 104 and to prevent the anode current from flowing at a value sufficient to actuate the relay.

The time constant of the control network 99-118 is such that the circuit 97 is relatively fast acting, whereas the time constant of the network 121-122 is longer so that the circuit 119 is slower acting than the circuit 97. The network 124-125 may be faster acting with a shorter time constant than the circuit network 99-118. This enables the control to remain closed during pauses common to speech and yet to open rapidly upon resumption of music.

In the circuit of Figure 4, two blocking frequencies are provided, either or both of which impart to the control system a biasing potential for cutting off the output from the control channel, thereby rendering it inoperative. The control signal may be an intermittent signal of predetermined audio frequency or a band of frequencies. In any case, however, while the control frequency lies within the audio frequency range, music and other signals in the full audio frequency range are prevented from operating the control system by the proper selection of the blocking frequencies which are also derived from the same audio frequency channel of the receiving system, preferably in the band of frequencies outside that representing the peak energy content of speech. The control frequency from the same audio frequency channel is a different frequency. In case the control frequency is intermittent, the thermal inertia of the rectifier or amplifier tubes or proper choice of time constants in the control channel of the rectifier circuit may be utilized to provide steady operation.

It will be appreciated that the control of the output through the rectifier 98 and circuit 97 may be made responsive to any suitable bands of audio frequency signals outside of the pass band of the circuit 119 and likewise the control provided by the rectifier 120 and the circuit 119 may be made responsive to the music or other frequency band in the audio frequency spectrum so that, for example, the control circuit may function whenever music is present in the output of the receiv-

ing system, but does not function for speech alone, thus muting the receiver for music, but not for speech.

A control system embodying the invention is particularly effective in connection with a broadcast signal receiving system to control a condition of operation thereof or the operation of an associated apparatus or circuit in response to signals of a predetermined audio frequency contained within the audio frequency band of the system without being operated by normal signals representing the full musical or audio frequency range of the system.

I claim as my invention:

1. A frequency responsive control system comprising in combination, an audio frequency signal channel, a tuned branch circuit coupled to said signal channel responsive to a predetermined frequency characteristic in an audio frequency band, a second tuned branch circuit responsive to a control frequency within said audio frequency band, a relay device, means including an electron discharge path for causing said relay device to operate in response to signals through said second branch circuit, and means to impede conduction through the discharge path for preventing the operation of said relay device in response to signals through said first branch circuit.

2. The combination with a radio receiving system having an audio frequency output circuit, of a frequency responsive control system connected with said circuit comprising a tuned branch circuit responsive to audio frequencies in a band containing maximum energy for music, a second branch circuit tuned to the framing pulses of a facsimile signal within the audio frequency band, an electron discharge tube responsive to the reception of the last named signals to cause operation of a control device, and means responsive to signals in said first named branch circuit for biasing the electron discharge tube to prevent the operation of said control device.

3. The combination with an audio frequency amplifier having an output circuit, of means for deriving therefrom audio frequency signals in a predetermined band, a frequency responsive system, an electron discharge tube, means for applying said derived signals to said system to block the conduction of said discharge tube, means for deriving audio frequency signals from said output circuit in a second band of audio frequencies, and means for applying said last named signals to said system for effecting conduction of said discharge tube in the absence of signals in said first named circuit.

4. The combination with a radio signal receiving system having an audio frequency amplifying channel, of means connected with said channel for deriving therefrom signals of a predetermined audio frequency contained within the band of audio frequencies inherent to music, an electron discharge tube, a controlled apparatus responsive to current through said tube, means for controlling the functioning of said electron discharge tube including a circuit connected with said audio frequency amplifying channel and responsive to said predetermined audio frequency within the said audio frequency band, and means responsive to signals in said band other than said predetermined frequency for biasing said tube for preventing the operation of said controlled apparatus.

5. The combination with a radio receiver having an audio frequency signal channel, of a sound producing device connected therewith, means for

cutting off the audio frequency output to said device, an amplifier tube for controlling said last named means, a circuit connected with said signal channel and responsive to frequencies within the range of speech for controlling said amplifier and the output of said sound producing device, a second circuit responsive to audio frequency signals outside the frequency range of speech, connected with said amplifier tube to prevent conduction therethrough in response to said last named signals, whereby said system is selectively responsive to music and nonresponsive to speech.

6. A frequency responsive selective switching system comprising in combination, an audio frequency signal conveying circuit, a tuned circuit coupled thereto responsive to a control signal at a frequency contained within a band of musical sound frequencies, a second tuned circuit coupled to said audio frequency circuit responsive to audio frequency signals in a band outside the major portion of the musical sound frequency range, a signal rectifier connected with each of said coupled circuits for individually producing control potentials in response to signals applied thereto, and selecting switching means including a relay and a controlling amplifier tube for said relay, said tube having a pair of control electrodes individually responsive to the control potentials produced by said rectifiers.

7. The combination with a signal receiving system, of an audio frequency amplifier circuit connected therewith for conveying signals therefrom, control potential responsive means for muting said circuit including an amplifier tube, a rectifier circuit coupled to said first named circuit and having an output bias potential control connection with said amplifier tube, said rectifier circuit being responsive to audio frequency signals in said first named circuit in a predetermined frequency band, means responsive to audio frequency signals outside said band for blocking the control function of said rectifier in the presence of musical sound frequencies, and a relay device connected in circuit with and controlled by said tube.

8. A selective switching system for facsimile receivers and the like, responsive to audio frequency impulses of a predetermined frequency contained within the audio frequency spectrum, comprising an amplifier tube, a relay device operative in response to the anode current variations of said tube, means providing a fixed biasing potential for said tube to prevent operation of said relay device in the absence of signals, a band pass audio frequency circuit, means for applying audio frequency signals thereto, a rectifier connected with said band pass circuit having an output circuit connected with said bias supply means to effect variation in the bias potential applied to said amplifier in the presence of signals within the pass band of said last named circuit, a second band pass audio frequency circuit coupled to the signal means of said first named band pass circuit and having a rectifier connected therewith in polarity opposition with the first named rectifier, thereby to cause operation of the relay device in the presence of signals in the second named band pass circuit and being prevented from operating said relay device when the applied signals comprise appreciable voltages in the band of frequencies to which the first named band pass circuit is responsive.

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