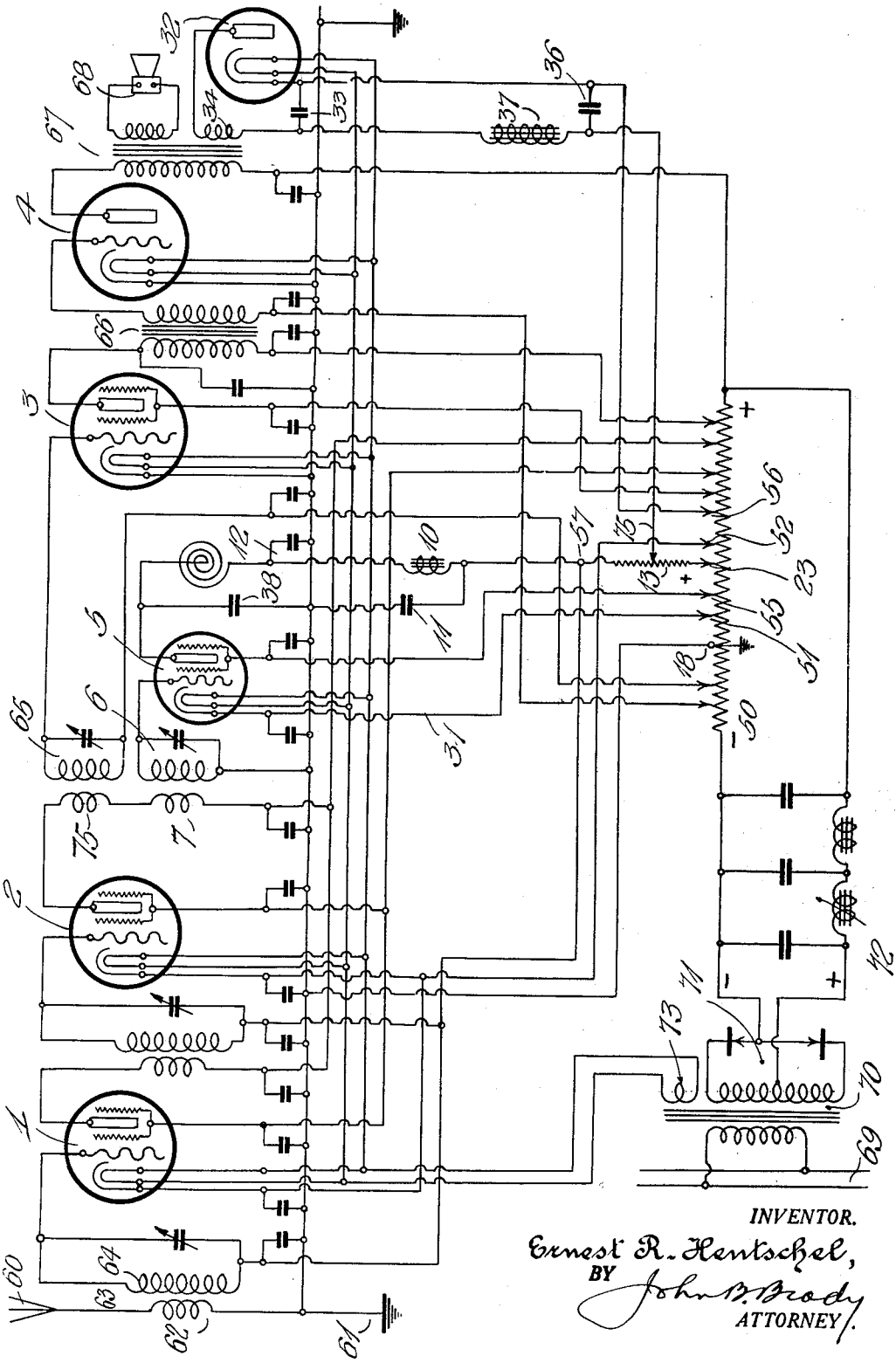
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VOLUME CONTROL SYSTEM

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VOLUME-CONTROL SYSTEM

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12 Claims. (Cl. 250—20)

My invention relates relates broadly to radio receiving apparatus and more particularly to a volume control system for radio receivers.

One of the objects of my invention is to provide a circuit arrangement for controlling the volume of reproduced sound in a radio receiving system by which both the amplitude of the carrier wave and the amplitude of the audio frequency current supplied to the sound reproducer are effective to control the volume of reproduced sound at the receiver.

Another object of my invention is to provide means for conjointly controlling the volume of sound reproduced at a receiver according to the amplitude of the incoming carrier frequency as well as the amplitude of the audio frequency current in the sound reproducer circuit.

Still another object of my invention is to provide a volume control circuit including a plurality of control circuits in a radio receiving system which are separately effective according to the amplitude of the incoming carrier frequency and the amplitude of the audio frequency current in the sound reproducer circuit.

A further object of my invention is to provide automatic means for controlling the operating characteristics of a radio frequency amplifier according to the amplitude of the incoming carrier frequency and in accordance with the amplitude of the audio frequency current in the circuit to the sound reproducer for maintaining the volume of reproduced sound substantially uniform.

A still further object of my invention is to provide a volume control circuit for radio receiving systems having a multiplicity of means for controlling the bias potential on the grid circuits of the electron tubes constituting the radio frequency amplifier portion of a radio receiving system according to both the amplitude of the incoming carrier frequency and the amplitude of the audio frequency current in the sound reproducer circuit.

Still another object of my invention is to provide means for automatically preventing chatter, noises, or distortions caused by overloading the sound reproducer by increase in amplitude of the incoming signaling energy under conditions of increase in the percentage of modulation of the incoming carrier wave.

Other and further objects of my invention reside in a system of dual regulation for controlling the volume of sound reproduced by a radio receiving apparatus as set forth more fully in the specification hereinafter following by reference to the accompanying drawing which diagrammatically illustrates the circuit arrangement of my invention.

Referring to the drawing in detail, the antenna-ground circuit is illustrated at 60—61 including the primary winding 62 of coupling transformer 63, the secondary winding of which is indicated at 64 as connected in the input circuit of the first stage of radio frequency amplification indicated at 1. The second stage of radio frequency amplification is shown at 2. An electron tube detector is illustrated at 3 having its input circuit 65 coupled to the output circuit of the last stage of radio frequency amplification indicated at 2 through the winding 75. The audio frequency amplifier is designated at 4 coupled through audio frequency transformer 66 with the output circuit of the detector tube 3. A transformer 67 is arranged in the output circuit of the audio frequency amplifier 4 and serves to couple the amplifier 4 to the sound reproducer 68. The power supply for the several circuits of the electron tubes may be obtained from any suitable source such as the alternating current power supply line 69 to which there is connected the power transformer 70. A rectifier circuit 71 is provided connected with a filter circuit 72 to the potentiometer 50 from which taps extend to the several circuits of the electron tube system as illustrated. A secondary winding 73 is provided on the transformer 70 and supplies alternating current for heating the several cathodes of the tubes as illustrated. A rectifier tube has been shown at 5 having its input circuit coupled through winding 6 with winding 7 which is disposed in the output circuit of the final stage of radio frequency amplification indicated at 2. The winding 7 in the output circuit of the radio frequency amplifier stage 2 is disposed in series with the winding 75 which forms the path heretofore explained for the signaling energy to the detector 3 and audio frequency amplifier 4. A separate rectifier tube is shown at 32 having its input circuit connected with secondary winding 34 of the output transformer 67 in the output circuit of the final stage of audio frequency amplification indicated at 4.

Considering first tube 5, radio frequency energy is transferred from coil 7 to coil 6 and impressed on the grid of tube 5. This grid is highly biased so that under normal conditions there is no plate current in this tube, but when the radio frequency variations exceed a certain predetermined amplitude as determined by loudness of sound, pulsations of plate current flow. The radio frequency component of these pulsations

travel through condenser 38 to the common ground. Condenser 12 is an audio frequency by-pass condenser and in combination with audio frequency by-pass condenser 11 and audio frequency choke 10 comprise an audio frequency filter which tends to smooth out this plate current to a steady value. This current then passes through resistance 13, tap 23, through the portion of potentiometer 50 included between taps 23 and 51, through line 31, to the cathode of tube 5. In flowing through resistance 13 a potential difference is set up across this resistance. This potential difference is applied to the control grids of tubes 1 and 2, in order to decrease the volume by limiting the amount of plate current in these tubes. The normal grid bias on tube 5 is equal to the potential difference between taps 51 and 18 on potentiometer 50. This bias is so adjusted that no plate current can flow in tube 5 until the volume of signal exceeds the desired value. The function of the filter which consists of coil 10 and condensers 12 and 11 is to prevent the bias on grids of tubes 1 and 2 from following the audio frequency fluctuations of the incoming signal.

The bias on the grids of tubes 1 and 2 is the potential difference between tap 52 on potentiometer 50 and terminal 57 on resistance 13. With no current in tube 5 and therefore no potential difference across resistance 13, this electromotive force is that between taps 52 and 23 on potentiometer 50. When the incoming signals become stronger than desired, and the plate of tube 5 begins to carry current, there will be a potential difference across resistance 13, which potential difference will be added to the bias already on the grids of tubes 1 and 2, which will cause the amplification in these tubes to become less, decreasing the amplitude of the signal supplied to the detector.

Tube 32 is another rectifier of the two-electrode type which is coupled to the audio frequency output circuit. It is also biased so that no current will be passed until after the volume of sound exceeds the desired value. Condensers 33 and 36 and choke coil 37 form an audio frequency filter so that the current which is passed back to resistance 13 will be of a steady character for the same reason as mentioned before. The path of this current is from the plate of tube 32 to coil 34, choke coil 37 tap 75 on resistance 13, tap 23 to potentiometer 50, tap 56 to the cathode of tube 32. It will be seen that the passage of this current has the same effect upon resistance 13 as the passage of current in tube 5; namely, the increase of the bias on the grids of tubes 1 and 2. It will be seen that the current in resistance 13 from tube 5 affects the bias on tube 32. However, the electromotive force in resistance 13 will be small as compared to that in potentiometer 50 between taps 56 and 23 and so has little effect upon the operation of tube 32. The purpose of adding tube 32 is so that if the percentage of modulation of the incoming signal is increased after adjustment of volume has been made in tube 5, the sounds in the loud speaker may become loud enough to cause vibration or chattering of the speaker even though volume control tube 5 is functioning. This is because the percentage of modulation varies. Tube 5 operates on the amplitude of the radio frequency carrier wave, whereas tube 32 operates on the amplitude of current supplied to the loud speaker. It is desirable of course that the loud speaker reproduce the variations of amplitude of sound directly as supplied to the transmitter in the transmitting station. However, at times these sounds are increased to such an amplitude that the ordinary loud speaker cannot satisfactorily handle them and therefore it is considered beneficial to have an auxiliary control device which operates directly on the volume of this sound. Under normal operation, the bias on tube 32 is so adjusted that it does not function until after tube 5 is brought into play.

If the percentage of modulation were always the same, then the loudness of sound in the speaker would always be proportional to the amplitude of radio frequency supplied to the detector and there would be no object in adding tube 32. But as the percentage of modulation does change and as it is possible that tube 5 may have been adjusted when the percentage of modulation was much less than 100 percent, it is desirable to have a second device which sets a limit on the amount of energy supplied to the speaker. Thus tube 32 operates as a safety device while tube 5 regulates the amount of radio frequency energy supplied to the detector. It is generally considered best to have a volume control device operated by the radio frequency carrier amplitude as this is received continuously while sounds are intermittent, and due to the necessity of large chokes there is a certain time lag in the action. Therefore, it is not feasible to eliminate tube 5 and use tube 32 only.

While I have described my invention in one of its preferred embodiments I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A radio receiving apparatus comprising a radio frequency amplifier portion, a detector, an audio frequency amplifier portion, a sound reproducer connected in the output circuit of said audio frequency amplifier portion, a source of power for said apparatus, means including an impedance connected with said source and with said radio frequency amplifier portion for automatically controlling the operating characteristics thereof, means operatively coupled to the output circuit of said radio frequency amplifier portion and responsive to variations in the amplitude of the amplified carrier wave therein for varying the voltage drop in said impedance and means operatively coupled to the output circuit of said audio frequency amplifier portion and responsive to variations in the percentage of modulation for varying the voltage drop in a portion of said impedance.

2. Apparatus in accordance with claim 1 in which said means operatively coupled to the respective output circuits of said radio frequency and audio frequency amplifiers comprise means for preventing the feed-back of radio- and audio-frequency ripples through said impedance.

3. A volume control system for radio receivers comprising in combination a radio frequency amplifier, a detector, an audio frequency amplifier, power supply means, a rectifier circuit connected with the output of said radio frequency amplifier, a separate rectifier circuit connected with the output circuit of said audio frequency amplifier, and means including an impedance the voltage drop in which is controlled by the conjoint operation of said rectifier circuits for regulating the operating characteristics of said radio frequency amplifier, said impedance being disposed in series between said power supply

means and at least one of the biasing circuits of said radio frequency amplifier and having operable connection with said rectifier circuits.

4. In a volume control system for a radio receiver having a radio frequency amplifier, a detector, an audio frequency amplifier and power supply means, the combination of a rectifier circuit connected with the output circuit of said radio frequency amplifier, a second rectifier circuit connected with the output circuit of said audio frequency amplifier, and means including a common circuit element connected in the output circuits of each of said rectifier circuits and operatively connected with the bias potential circuit of said radio frequency amplifier for controlling the operating characteristics of said radio frequency amplifier, said means being responsive to variations in the amplitude of the carrier wave delivered by said radio frequency amplifier by virtue of its operable connection with the first said rectifier circuit and said means being further responsive to variations in the percentage of modulation existent in said audio frequency amplifier by virtue of its operable connection with the second said rectifier circuit.

5. Apparatus in accordance with claim 4, in which said means including a common circuit element comprise an ohmic resistance one terminal of which is connected to said power supply means, another terminal of which is connected to the rectifier circuit which is associated with the radio frequency amplifier, said terminal being also connected to the said bias potential circuit and said ohmic resistance having an intermediate tap connected with said rectifier circuit which is associated with the audio frequency amplifier.

6. A volume control system for a radio receiver having a radio frequency amplifier portion, a detector, an audio frequency amplifier portion and a power supply circuit, comprising in combination, a potentiometer connected in said power supply circuit, a resistance member connected to said potentiometer and to at least one biasing circuit of said radio frequency amplifier portion, and means including a pair of auxiliary electron tubes the impedances of which are controlled by said radio frequency and said audio frequency amplifier portions respectively and which are operably connected with said resistance member for varying the voltage drop therein in such manner that the potential applied to said biasing circuit is varied to a certain degree under control of the amplitude variations in the output circuit of the radio frequency amplifier portion and, to a lesser degree, under control of the amplitude variations in the output circuit of the audio frequency amplifier portion.

7. A volume control system for a radio receiver having a radio frequency amplifier, a detector, an audio frequency amplifier and a power supply circuit, comprising in combination, a potentiometer connected with said power supply circuit and having thereon a bias potential supply tap, means including an impedance in circuit between said tap and the biasing circuit of said radio frequency amplifier for controlling the bias potential supplied thereto, and means for varying the potential drop in said impedance, said means including separate rectifiers each having its input circuit coupled respectively with the output circuits of said radio frequency and audio frequency amplifiers and said rectifiers having their output circuits operably connected to said impedance.

8. In a radio receiving system having electron tubes disposed in a radio frequency amplifier, a detector, and an audio frequency amplifier, a pair of control electron tubes one of which is responsive to a portion of the output energy from the radio frequency amplifier and the other of which is responsive to a portion of the output energy from said audio frequency amplifier, means including a source of energy and a biasing circuit for controlling the amplification characteristics of said radio frequency amplifier and means including an impedance element connected in series in said biasing circuit and likewise in the output circuits of said control electron tubes for controlling the bias potential supplied to said radio frequency amplifier in response to variations in the mutual conductance of said control electron tubes.

9. In a radio receiving system, a radio frequency amplifier tube, a detector, an audio frequency amplifier tube, a primary control electron tube having its input circuit in electrical relation with the output circuit of said radio frequency amplifier tube, a secondary control electron tube, means for impressing on said secondary control electron tube a portion of the output energy of said audio frequency amplifier tube for controlling the output current of said secondary control tube, a source of potential for biasing the control grid of said radio frequency amplifier tube, an impedance element connected in series with the grid circuit of said radio frequency amplifier tube and said source of biasing potential, at least a portion of said impedance element being connected in the output circuit of said primary control tube, and at least a portion of said impedance element being connected in the output circuit of said secondary control tube, whereby the outputs of said radio frequency amplifier tube and said audio frequency amplifier tube cooperatively control the potential of the grid of said radio frequency amplifier tube.

10. In a radio receiver having electron tubes for radio frequency amplification, detection and audio frequency amplification, the method of limiting the amplitude of the carrier frequency waves as delivered by the radio frequency amplifier and in a lesser degree limiting the amplitude of the audio frequency components delivered by the audio frequency amplifier which comprises utilizing a portion of the output energy of the radio frequency amplifier for controlling the bias potential as supplied to said radio frequency amplifier and utilizing a portion of the output energy of said audio frequency amplifier for varying to a lesser degree said bias potential.

11. In a volume control for a radio receiver, the method as defined by the steps recited in claim 10 and in addition thereto the step of filtering the portions of energy derived from said radio frequency amplifier and said audio frequency amplifier respectively, whereby the bias potential is leveled off and rendered immune to the ripple effects of said carrier frequency and audio frequency components.

12. In a radio receiver having a sound reproducer, means responsive to amplitude variations of the received signal for controlling the amplitude of the radio frequency detected without unduly leveling off the desirable variations in the amplitude of the audio frequency components thereof, and means responsive to an excess of amplitude of the modulation components of said signal for limiting the amount of energy supplied to said sound reproducer.

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