Nov. 12, 1935. V. D. LANDON 2,020,363

AUTOMATIC VOLUME CONTROL ARRANGEMENT

Filed Aug. 19, 1933 2 Sheets-Sheet 1

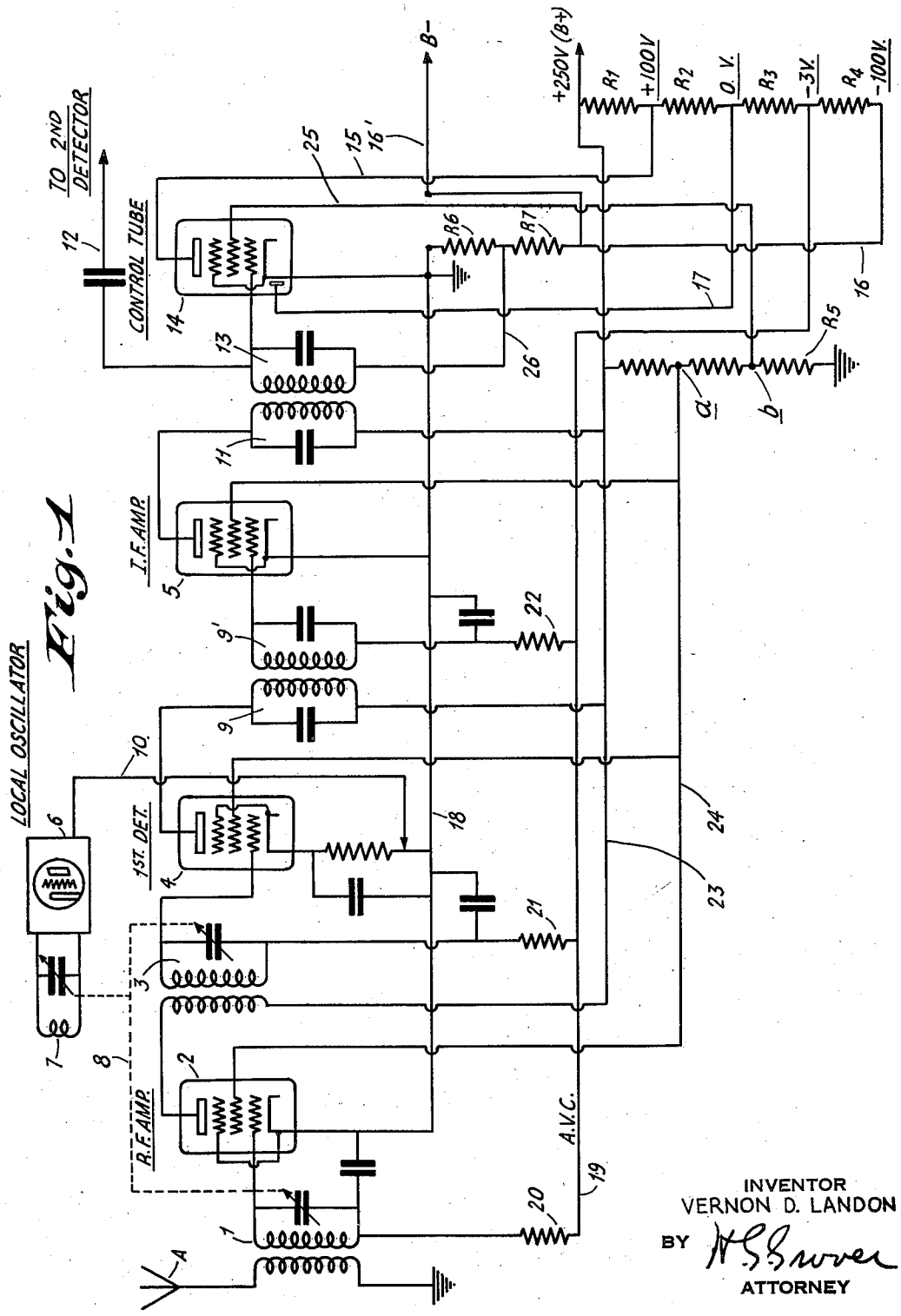


Fig. 1

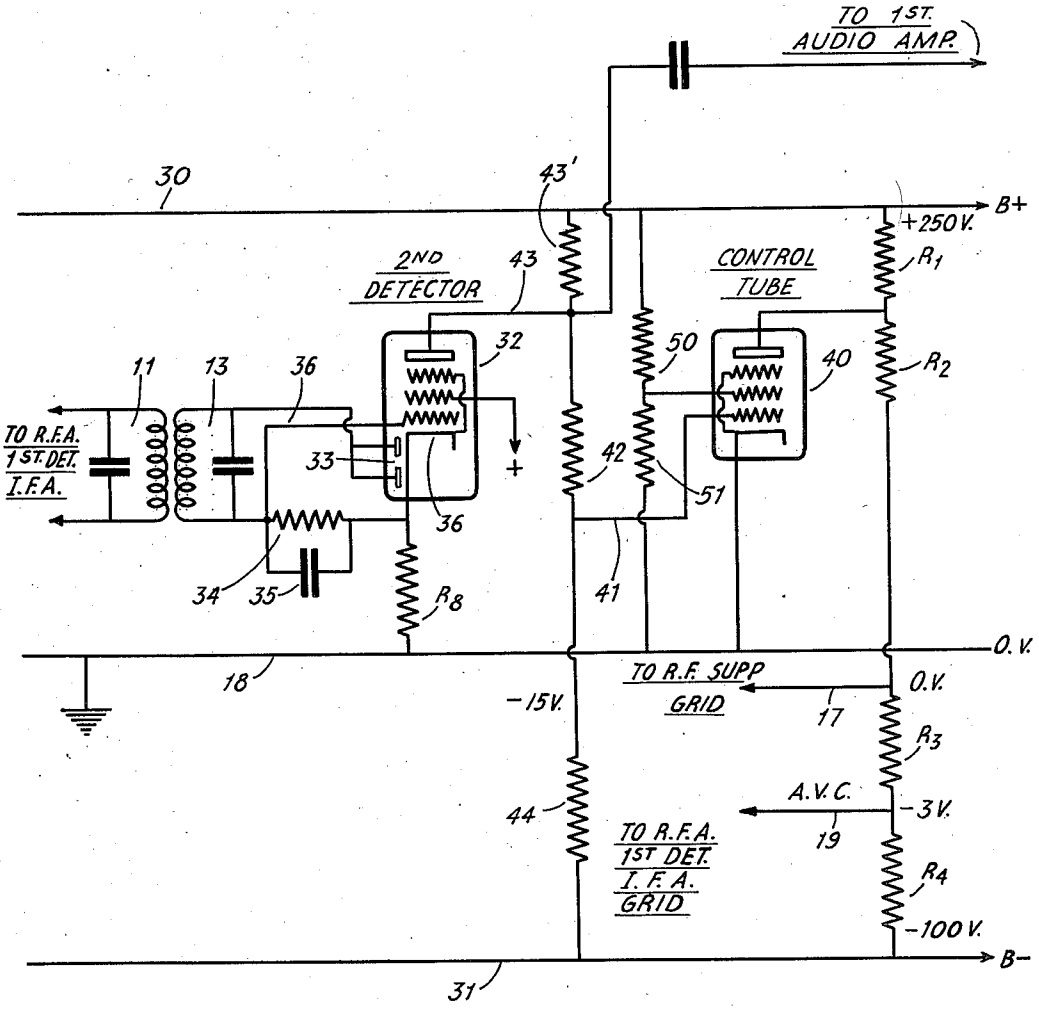
INVENTOR
VERNON D. LANDON
BY
ATTORNEY

Nov. 12, 1935. V. D. LANDON 2,020,363

AUTOMATIC VOLUME CONTROL ARRANGEMENT

Filed Aug. 19, 1933 2 Sheets-Sheet 2

Fig. 2



INVENTOR
VERNON D. LANDON
BY H. S. Grover
ATTORNEY

Patented Nov. 12, 1935

2,020,363

UNITED STATES PATENT OFFICE

2,020,363

AUTOMATIC VOLUME CONTROL ARRANGEMENT

Vernon D. Landon, Collingswood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 19, 1933, Serial No. 685,965

9 Claims. (Cl. 250—20)

My present invention relates to gain regulation systems, and more particularly to automatic volume control arrangements for radio receivers.

It is old in the art to use a separate tube for the A. V. C. function of radio receivers. However, this always has involved undesirable complication in the B supply system. It has hitherto been impossible, when using a separate A. V. C. tube, to self-bias or ground all cathodes and have all grid returns (with no applied signal) at, or near, ground potential. The reason is obvious; the B supply of the A. V. C. tube is in series with the B supply of the RF tubes in all past examples of this system. Either —B is grounded and the RF cathodes placed about 100 volts positive with respect to ground, or the RF cathodes are grounded (or self-biased to ground) placing —B about 100 volts negative to ground. Each of these expedients is highly undesirable.

My solution of the problem eliminates the necessity of placing the two B supplies in series. True it requires a voltage 100 volts negative to ground. However, this connects only to a portion of the circuit in which hum is easily filtered out due to the high impedance level, and hence the drop across a filter reactor may be utilized. Hence, the chief object is to obtain the advantage of a separate A. V. C. tube with its flat A. V. C. characteristic without some of the disadvantages.

Another prime object of my present invention is to provide an automatic volume control arrangement for a radio receiver wherein, unlike automatic volume control systems known in the prior art, the control rectifier tube output electrode is at a positive potential with respect to the cathodes of one or more controlled high frequency amplifiers.

Another important object of the present invention is to provide in an automatic volume control arrangement for a radio receiver, a volume control tube whose output electrode is at a positive potential with respect to the cathode of a controlled tube preceding the control tube.

Other objects of the present invention are to generally improve known automatic volume control systems, and to particularly provide an improved volume control system of the presently disclosed type which is not only reliable and durable in operation, but economically manufactured and assembled in a radio receiver.

The novel features which I believe to be characteristic of my invention are set forth in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawings in which I have indicated diagrammatically several arrangements for carrying my invention into effect.

In the drawings,

Fig. 1 diagrammatically shows one form of the present invention,

Fig. 2 shows a modification of the invention.

Referring now to the accompanying drawings wherein like reference characters in the different figures designate similar circuit elements, there is shown in Fig. 1 a conventional form of superheterodyne receiver embodying one form of the invention. While the invention is disclosed in connection with a superheterodyne receiver, it is to be clearly understood that the receiver can be of the cascaded tuned radio frequency amplifier type. The various circuits of the superheterodyne receiver will only be described briefly since those skilled in the art are well aware of the specific connections of a superheterodyne receiver of the type shown in Fig. 1.

A signal collecting means, such as a grounded antenna circuit A, is coupled to the tunable input circuit 1 of a radio frequency amplifier 2 whose gain is to be automatically regulated. The tube 2 is of the radio frequency pentode type, and known as a 58 tube, the anode circuit of the tube being coupled to a tunable input circuit 3 of the first detector tube 4. The first detector tube is also of the pentode type, and, with the succeeding intermediate frequency amplifier tube 5, is of the 58 type.

The local oscillator 6 of the receiver is conventionally shown, its tunable circuit 7 being represented as including a variable tuning condenser, which variable tuning condenser is uni-controlled with the variable tuning condensers of circuits 2 and 3, this being represented by the dotted lines 8. In the anode circuit of the pentode first detector tube there is included a network 9 resonant to the opertaing intermediate frequency, this network 9 being coupled to a similar network 9', also tuned operating intermediate frequency, this network 9 being disposed in the grid circuit of the intermediate frequency amplifier 5. A line 10 represents the connections between the local oscillator 6 and the cathode circuit of the first detector tube 4, and it is to be understood that this numeral 10 designates the conventional connections which couple the local oscillator and first detector.

The anode circuit of the tube 5 includes a resonant circuit 11 tuned to the intermediate frequency, the intermediate frequency energy in the circuit 11 being fed to two paths. One of

these paths, represented by the numeral 12, includes the second detector and succeeding audio frequency network, the circuits connected to the path 12 being omitted to preserve simplicity of disclosure. The second path to which the intermediate frequency energy of network 11 is fed, includes the circuit 13, tuned to the intermediate frequency, and coupled to circuit 11. The automatic volume control tube is designated by the numeral 14, and the circuit 13 is disposed in the grid circuit of tube 14, the latter being a tube including independent diode and pentode sections and is of the 2B7 type.

The circuits described up to this point are generally well known to those skilled in the art, and it will be recognized that the tube 14 functions as a source of direct current control potential for regulating the gain of the radio frequency amplifier tube 2, the first detector tube 4 and the intermediate frequency amplifier tube 5. In systems known heretofore the anode of the control tube 14 has been at a negative potential with respect to the cathodes of the controlled tubes. However, by means of the present invention these controlled tubes have their cathodes at a negative potential with respect to the output electrode of the control rectifier.

Furthermore, the present system of automatic volume control is accomplished in a practical and easily manufactured circuit, and with a minimum of auxiliary circuit elements. This is accomplished by connecting the anode of tube 14 to the low potential side of resistor R_1 of the power source bleeder through a lead 15. The high potential side of resistor R_1 is connected to the positive terminal of the positive potential supply source, this source being omitted, but it being clearly understood that it may be the usual filtered rectified alternating current source, or even a direct current source. The negative side of the potential supply source is represented by the symbol (—B), and the negative side of the bleeder is connected to the —B terminal through a path which includes the lead 16 and 16'. The bleeder comprises four resistors in series, these being designated as R_1, R_2, R_3, and R_4. A practical set of values for these resistors, it being emphasized that these values are merely illustrative, are as follows:

R_1=300,000 ohms; R_2=180,000 ohms; R_3=6,000 ohms; R_4=194,000 ohms.

The junction of resistors R_1 and R_2 is designated as being of a value of +100 volts, the junction between resistors R_2 and R_3 is designated as having a potential of 0 volts, while the junction of resistors R_3 and R_4 has a value of —3 volts, and the negative side of resistor R_4 has a potential value of —100 volts.

The diode anode of control tube 14 is connected by a lead 17 to the junction of resistors R_2 and R_3, and therefore this diode anode is at zero volt potential, or at ground potential. The automatic gain regulation path, designated "A. V. C." includes a lead 19 having one terminal thereof connected to the junction of resistors R_3 and R_4, the lead 19 being connected to the grid circuits of tubes 2, 4 and 5 through resistors 20, 21 and 22 respectively. Appropriate radio frequency by-pass condensers are connected between the grid and cathode electrodes of each of tubes 2, 4 and 5, and the usual common cathode potential supply connection is made to the anodes of tubes 2, 4, and 5 through lead 23.

The anode of control tube 14 is connected by lead 15 to a point of +100 volts on the supply bleeder, while the anodes of the preceding tubes are supplied with a potential of 250 volts. Proper screen grid potential is secured for the tubes by connecting a secondary bleeder resistor R_5 between lead 23 and ground, and then connecting the lead 24 between the screen grid leads of tubes 2, 4 and 5, and point *a* on bleeder R_5. The lead 25 connects the screen grid of tube 14 to point *b* on bleeder R_5, this point being at a less positive potential than point *a*. The control grid of tube 14 is connected through tuned circuit 13 and lead 26 to a point intermediate resistors R_6 and R_7, one side of resistor R_7 being connected to lead 16 and the —B terminal, while one side of resistor R_6 is connected to the grounded cathode of tube 14.

The resistors R_1, R_2, R_3, R_4 are so proportioned as to give the indicated voltages to ground when the control tube 14 is cut off, and this is the normal zero signal condition. When a very strong signal is tuned in the potential values associated with these last named resistors become respectively +250 volts, +20 volts, —40 volts, —43 volts, and —100 volts, effectively approaching cut-off of the radio frequency tubes. Of course, a moderately strong signal will only partially cut off the controlled tubes in the manner usual to automatic volume control systems.

It will be observed that an accurate balance is required between the values of R_1, R_2 and R_4, to prevent the voltages marked zero volts and —3 volts from varying badly under zero signal conditions. To remove this difficulty, the resistors are first calculated on a voltage divider basis as indicated. The value of R_2 is then decreased 10 or 15 per cent. This would cause the voltage on the positive terminal of R_3 (0 V. point) to rise to possibly 10 volts positive if the diode connection were not present. In fact, the voltages remain practically unchanged because of the diode current which flows when the diode plate is very slightly positive. Each of the resistors may now be varied over moderate limits without affecting the bias on the amplifier tubes appreciably. About one-half mil of plate current in the automatic volume control tube would be required to cut off the amplifier tubes plate current in this preferred embodiment.

When the diode connection is made, the potential of the positive end of R_3 becomes the same as ground potential within one or two tenths of a volt due to the diode current which flows. Moderate variations in the values of R_1, R_2 and R_4 now cause unappreciable variations in the potentials of the terminals of R_3 to ground. When a signal is applied, the A. V. C. tube does not start to function until the signal amplitude reaches a predetermined value of several volts on the grid of the A. V. C. tube. Plate current then flows, increasing the current in R_1 and decreasing that in R_2, R_3 and R_4. The potentials of the terminals of R_3 cause negative biasing off of the radio frequency amplifiers just sufficient to maintain the radio frequency voltage applied to the A. V. C. tube at the desired value over a wide range of input amplitudes.

In Fig. 1 the automatic volume control tube is shown actuated with intermediate frequency on its grid. By adjusting the ratio of screen voltage to bias voltage, the intermediate frequency voltage required to barely start plate current may be adjusted to any desirable value such as 10 volts of intermediate frequency. Increasing this one or two more volts will be sufficient to cut off the radio frequency tubes. Hence, a very flat

curve will be obtained, of radio frequency input to the receiver versus audio output. It is sometimes desirable to keep intermediate frequency out of the automatic volume control tube to prevent the intermediate frequency harmonics being fed back to the input circuit. This makes it desirable to actuate the automatic volume control tube with direct current.

In Fig. 2 there is shown a circuit arrangement for actuating the automatic volume control tube with a direct current component. As in the case of Fig. 1 the power potential supply source is not shown, but the leads 30 and 31 are to be understood as connected to the +B and —B terminals of the power potential source. The resonant circuits 11 and 13, which were described in connection with Fig. 1 as tuned to the operating intermediate frequency, are connected between the intermediate frequency amplifier network and the second detector. It will be understood that the networks preceding circuit 11 are similar to those shown in Fig. 1 preceding the circuit 11 therein. The second detector tube is of the type known as an 85 tube, and is of the duplex diode pentode type. That is to say, the tube 32 includes a pentode section independent of a pair of diode sections. This type of tube is now well known to those skilled in the art, and most generally comprises a common cathode sleeve for the diode and pentode sections, the diode anodes 33 in the present case being strapped together and connected to the high potential side of circuit 13.

The cathode is connected to the low potential side of circuit 13 through a resistor 34 shunted by a condenser 35, the control grid of the pentode section being connected by lead 36 to the ungrounded side of resistor 34. The electron stream from the cathode 36 to the electrodes of the pentode section of tube 32 is independent of the electron stream flowing to the diode anodes 33. For this reason the tube 32 functions in a dual capacity. One of these capacities comprises diode rectification for second detection, while the other capacity comprises pentode amplification, of the audio frequency component of the second detection step. The audio frequency amplifier network usually connected to the output electrode of the pentode section of tube 32 is not shown, but the circuit necessary for the utilization of the direct current component of the pentode section output is shown.

The automatic volume control tube is of the pentode type, as in Fig. 1, and has its control grid connected to the anode of the pentode section of tube 32 through a path which includes lead 41, resistor 42 and lead 43. The lead 43 is connected to the positive potential lead 30 through a resistor 43'. The low potential side of resistor 42 is connected to the negative potential lead 31 through a resistor 44, the less negative side of resistor 44 being at a potential of about —15 volts. The ground lead 18 is connected to the cathode 36 of tube 32 through a bias resistor R_8, but it is to be noted that if the diode second detector does not have to be maintained at a positive potential, the detector cathode resistor R_8 may be omitted.

The bleeder R_1, R_2, R_3, and R_4 is employed as in Fig. 1 the anode of tube 40 being connected to the junctions of resistors R_1 and R_2, the zero volt side of resistor R_3 being connected, as in Fig. 1, through lead 17 to the suppressor grid of the radio frequency amplifier tube 2. The automatic volume control lead 19 is connected to the —3 volt point of resistor R_4 as in Fig. 1, the remaining connections being the same as in this last named figure. The screen grid potential for tube 40 is derived from the junction of resistors 50 and 51, the latter resistors being connected in series between leads 30 and 18.

The control grid of the tube 40 is maintained well below cut-off since the voltage divider is disposed in the plate circuit of the detector tube 32, this arrangement being similar to that employed in Fig. 1. Hence, any moderate change in the values of the detector plate resistors simply changes by a slight amount the values of bias change required to begin to actuate the automatic volume control tube. It should be noted that in Fig. 2 all the elements of both tubes, except the control grid of tube 40, are at all times positive with respect to ground. The cathodes of the signal amplifier tubes, as shown in Fig. 1, are of course grounded.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. In combination, a signal amplifier, a control tube, a voltage divider, means for connecting the output electrode of said control tube to a point of positive potential on said divider, an amplifier gain control connection conductively connecting the signal control grid of said amplifier to a point on said divider which is negative with respect to said first point, means for maintaining the cathodes of the amplifier and control tube at a common voltage which is intermediate the voltage of said two points, and means for transferring amplified signal energy from said signal amplifier to the input circuit of said control tube.

2. In combination, a signal amplifier, a control tube for regulating the amplifier gain, a voltage divider, means for connecting the output electrode of said control tube to a point of positive potential on said divider, a gain control connection conductively connecting the signal control grid of said amplifier to a point on said divider which is negative with respect to said first point, means for transferring amplifier signal energy from said signal amplifier to the input circuit of said control tube, means for maintaining the amplifier and control tube cathodes at a common positive voltage with respect to the amplifier grid, and means for connecting the control grid of the control tube to a point in the divider circuit of such negative potential that the control tube is cut off in the absence of signal energy.

3. An automatic volume control for a receiver, the latter including at least one signal amplifier provided with a tube having a cathode, an anode and a control grid, said control comprising a succeeding control tube provided with a cathode, control grid and plate, means for coupling the grid of the control tube and the anode circuit of the preceding amplifier, a common source of direct current voltage for the amplifier and control tube, means for establishing the cathodes of the amplifier and control tube at a common voltage, a gain control connection from the amplifier grid to a point on said source which is at a predetermined negative voltage with respect to a second point on the said source, said second point being at a voltage equal to that of said common voltage, a connection from the control tube

anode to a third point on said source which is positive with respect to the first two points.

4. In a system as defined in claim 3, a connection from the said cathodes to the negative terminal of said source.

5. In a system as defined in claim 3, means in the space current path of the control tube for maintaining the control tube grid at cut-off voltage in the absence of received signals.

6. In a system as defined in claim 3, an auxiliary anode in the control tube, and a connection from the auxiliary anode to said second point on the voltage source.

7. An automatic volume control for a receiver, the latter including at least one signal amplifier provided with a tube having a cathode, an anode and a control grid, said control comprising a succeeding control tube provided with a cathode, control grid and plate, means for coupling the grid of the control tube and the anode circuit of the preceding amplifier, a common source of direct current voltage for the amplifier and control tube, means for establishing the cathodes of the amplifier and control tube at a common voltage, a gain control connection from the amplifier grid to a point on said source which is at a predetermined negative voltage with respect to a second point on the said source, said second point being at a voltage equal to that of said common voltage, a connection from the control tube anode to a third point on said source which is positive with respect to the first two points, said voltage source comprising a plurality of resistor elements arranged in the space current path of the control tube, the voltages of the first and second points become increasingly negative with signal amplitude increase, and the voltage of the third point becomes less positive.

8. An automatic volume control for a receiver, the latter including at least one signal amplifier provided with a tube having a cathode, an anode and a control grid, said control comprising a succeeding control tube provided with a cathode, control grid and plate, means for coupling the grid of the control tube and the anode circuit of the preceding amplifier, a common source of direct current voltage for the amplifier and control tube, said source comprising a plurality of resistors arranged in series in the control tube space current path, means for establishing the cathodes of the amplifier and control tube at a common voltage, a gain control connection from the amplifier grid to a point on said source which is at a predetermined negative voltage with respect to a second point on the said source, said second point being at a voltage equal to that of said common voltage, a connection from the control tube anode to a third point on said source which is positive with respect to the first two points, and an additional signal amplifier, interposed between the first amplifier and control tube, and having its cathode at the said common voltage and its grid connected to the said first point.

9. An automatic volume control for a receiver, the latter including at least one signal amplifier provided with a tube having a cathode, an anode and a control grid, said control comprising a succeeding control tube provided with a cathode, control grid and plate, means for coupling the grid of the control tube and the anode circuit of the preceding amplifier, a common source of direct current voltage for the amplifier and control tube, means for establishing the cathodes of the amplifier and control tube at a common voltage, a gain control connection from the amplifier grid to a point on said source which is at a predetermined negative voltage with respect to a second point on the said source, said second point being at a voltage equal to that of said common voltage, a connection from the control tube anode to a third point on said source which is positive with respect to the first two points, said voltage source comprising a resistive potentiometer arranged in the control tube plate circuit, and a signal demodulator coupled to the amplifier anode circuit.

VERNON D. LANDON.