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AUTOMATIC VOLUME CONTROL

2,207,905

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Fig. 1

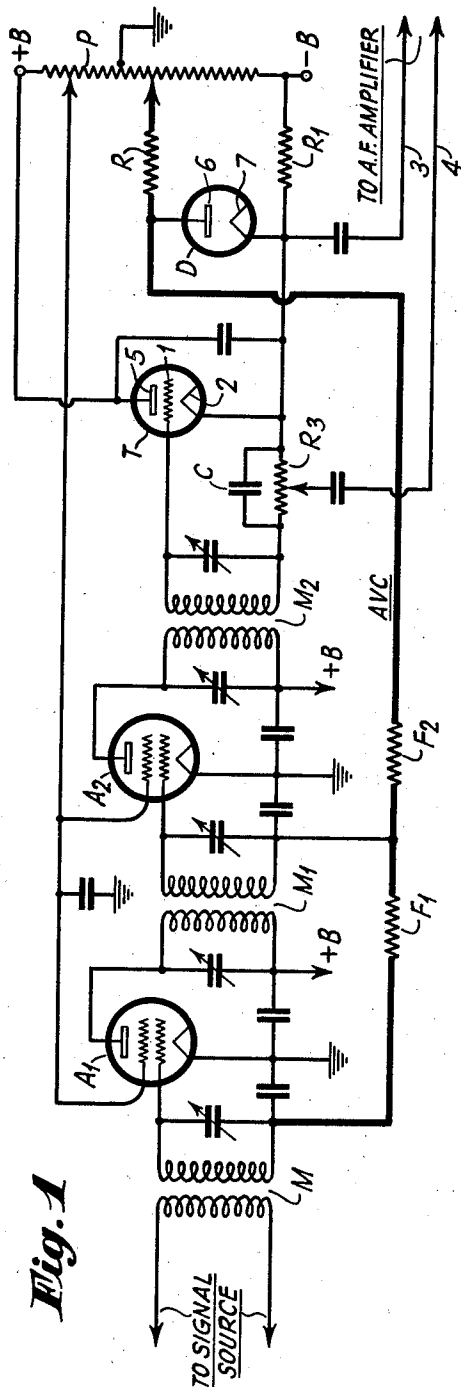


Fig. 2

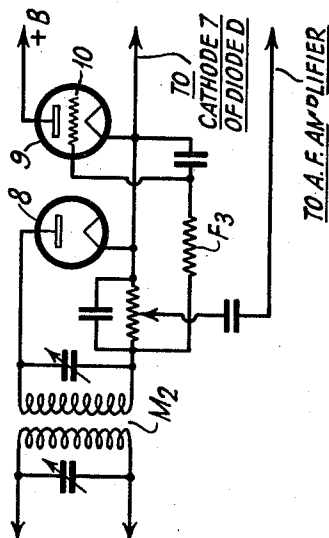
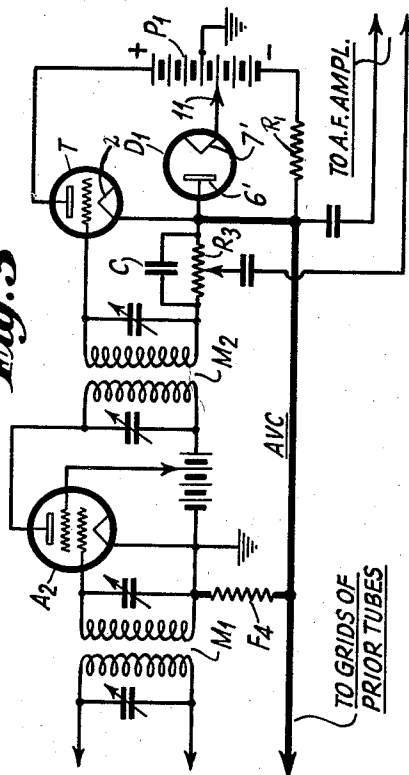


Fig. 3



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AUTOMATIC VOLUME CONTROL

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4 Claims. (Cl. 250—20)

The present invention relates to automatic volume control of radio receivers, and its main object is to provide a system of control such that the magnitude of the voltage utilized for control purposes has a lower limit in the case of extremely weak signals and an upper limit in the case of very strong signals, which limits are both independent of the exact characteristics of the detector system tube.

Further objects are to provide a control voltage which may reach a large magnitude, and, also, to obtain a rapid variation of control voltage with increasing strength of signals impressed upon the detector system.

Briefly, I obtain the objects of my invention by connecting the gain control grid or grids of the amplifier tubes by way of separate paths to separate bias potential points whose potentials are the limiting values of the range of control potentials desired, and by utilizing the detector output for rendering one of these paths increasingly effective relative to the other with increasing detector output and vice versa, so that the effective control potential changes continuously from approximately one limiting value to the other limiting value as the detector output changes from one predetermined value to another predetermined value. It will thus be seen that a very rapid increase of control voltage with respect to increase of detector input may be obtained, with a corresponding improvement in control action.

In the drawing:

Fig. 1 shows the pertinent portions of a receiver circuit employing the present invention,

Fig. 2 shows an alternative form of detector that may be substituted for the detector system of Fig. 1,

Fig. 3 shows an alternative form of the invention.

Referring to Fig. 1, there may be used a source of modulated high frequency currents such as an antenna; or in the case of a superheterodyne receiver, the converter tube. Voltage from the signal source is impressed on the input electrodes of amplifier tube A₁, and the amplified output of this tube is impressed on a second amplifier tube A₂ whose output is in turn applied between grid 1 and cathode 2 of triode tube T through bypass condenser C. A high resistance R₃ is connected across condenser C to provide a leakage path between grid 1 and cathode 2. It is not believed necessary to describe in detail the operation of the amplifying stages including tubes A₁ and A₂, since any of the well known amplifier arrange-

ments may be used, except to point out that tubes A₁ and A₂ are preferably of the "supercontrol" type; that is, they are so constructed that the amplification provided by the tubes is determined by their grid bias and may be varied over wide limits by varying the grid bias without introducing serious distortion. Condenser C together with resistance R₃ determine a time constant suitable for permitting modulation frequency voltages to build up across R₃ and a desired portion of this voltage is led off by way of leads 3 and 4, in which series blocking condensers may be connected as shown, to any desired form of utilization device, such as, for example, an audio frequency amplifier feeding into a loudspeaker. The development and the utilization of modulation frequency voltages is quite conventional in the present state of the art and need not be described further.

In addition to modulation frequency voltage there also exists a direct voltage component across R₃ which increases in accordance with the amplitude of the carrier component of the signal voltage applied to tube T. As a result of this negative potential on grid 1 the average current to anode 5 decreases more and more as the signal voltage applied to grid 1 increases. Anode 5 is connected to the positive terminal, marked +B in the drawing, of any suitable source of direct voltage, while cathode 2 is connected through a resistance R₁ to the negative terminal, -B, of the same source. An intermediate point on this source is connected to the cathodes of amplifier tubes A₁ and A₂, this connection being indicated in the drawing by a ground symbol. In the drawing the source of direct potential is indicated as a potentiometer P whose terminals +B and -B are supplied with direct current from any suitable source, such as the usual alternating current rectifier and filter, not shown. Of course, a battery may be employed in place of potentiometer P if desired.

A small bias, such as suitable for permitting high amplification, is provided for the control grids of tubes A₁ and A₂ by a conductive connection from their grids through filter resistors F₁ and F₂ and resistor R to a point on potentiometer P whose potential is a few volts more negative than ground. For the purpose of providing a large bias on the grids of tubes A₁ and A₂ in the presence of large amplitude signals impressed on detector T, an auxiliary two electrode valve D has its anode 6 connected to the junction of resistances R and F₂ while its cathode 7 is connected directly to cathode 2 of triode T. Thus,

valve D may be the diode section of the commonly used triode-diode type of tube, while triode T may be the triode section of the same tube, the cathodes of the two sections of such tubes being connected together within the tube. It is to be understood that the reference characters M, M₁, M₂ denote the usual coupling transformers each having primary and secondary circuits tuned to the carrier frequency of received signals.

The action of this arrangement is as follows: In the presence of weak signals or no signals at all, considerable space current traverses triode T and hence resistor R₁. The voltage drop across R₁ thus makes the potential of cathode 1 more positive than the potential of the connection of R to P, so that no current flows through D and hence the bias on the grids of tubes A₁ and A₂ is the potential of the junction of R and P. This bias remains constant until signals impressed on grid 1 of tube T are sufficiently strong to cut down the space current of tube T to a value so small that the potential of cathode 1 of valve D drops below the potential of its anode 6 whereupon the resulting current through valve D, and hence also through resistor R, causes a voltage drop through R that increases the bias on the grids of tubes A₁ and A₂. Thus after signals impressed on detector T reach a predetermined value, the bias on amplifier tubes A₁ and A₂ increases rapidly until the signal strength reaches a value which reduces the space current through triode T, and hence through R₁ to substantially zero, coincidentally with which the bias approaches as a limit the potential of the negative end, -B, of the source of direct voltage.

The higher the resistance R in comparison with R₁ and the resistance of valve D the more nearly will the potential of anode 6 of valve D approach that of the -B terminal in the absence of space current through detector T. It is thus seen that for signals above a predetermined strength the automatic volume control voltage, in other words the bias on the grids of tubes A₁ and A₂, is determined chiefly by the potentials of the points of connection to source P, and is relatively little dependent upon signal strength or the cathode emission of triode T. On the other hand, for very weak signals, the bias is also independent of tube characteristics, being determined only by the point of connection of R to P so that the only effect of variations in the characteristics of individual tubes in the detector position is a slight change in the amount of "delay" that occurs as signal strength increases before the automatic volume control voltage begins to increase.

Fig. 2 shows how a diode detector 8 may be used in conjunction with a triode 9 in place of triode T of Fig. 1. Since the cathodes of triode 9 and diodes 8 and D are all connected together, a single tube of the double diode-triode type may be used in place of three separate tubes if desired. A double diode-pentode tube could also be used, it being understood that the screen and suppressor electrodes of such a tube would be suitably connected to proper voltage supply sources as well known to those skilled in the art.

Fig. 3 shows a modified form of the invention wherein a conductive connection is provided from the grid-cathode circuit of amplifier A₂ to a source of high bias such as required for reducing the gain of amplifier tube A₂ to an extremely small value, while a unilaterally conductive space charge device is employed in a corresponding connection to a source of low bias suitable for

permitting maximum gain. Signals amplified by tube A₂ are impressed upon, and rectified in, the grid-cathode circuit of triode T, and audio output is taken from resistor R₃ all as described in connection with Fig. 1. Cathode 2 of triode T is connected through resistor R₁ to a point on direct voltage source P₁ whose potential is considerably more negative than that of the cathode of amplifier tube A₂. Thus, if sufficiently strong signals are impressed on the grid 1 of tube T to reduce the space current of tube T to nearly zero, the potential of cathode 2 will be considerably negative with respect to the cathode of A₂. Since the grid return of tube A₂ is made by way of filter resistor F₄ to the cathode of tube T, a sufficient bias is thus impressed on tube A₂ to reduce its amplification to a small value. As the impressed signals diminish, the increasing space current of tube T causes its cathode 2 to become less and less negative. If tube T is of unusually low resistance, cathode 2 might even in the absence of signals become somewhat positive, thus making the bias on tube A₂ positive. Since positive bias is generally undesirable on amplifier tubes, however, diode D₁ is provided having a low resistance in one direction, with its plate 6' connected to cathode 2 and its cathode 1' connected to a point 11 whose potential is somewhat more negative than that of the cathode of tube A₂. Thus, if the potential of cathode 2 tends to rise above the potential at point 11, current flows through the diode and thus by diverting the major portion of any further increase of space current of tube T from flowing through resistor R₁ prevents the zero signal bias of tube A₂ from becoming positive, or less than a suitable value for optimum amplifying action.

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 a radio receiver, a signal transmission tube, a signal rectifier tube of the type including at least a cathode, signal grid and output electrode, a signal input circuit for said rectifier tube coupled to said transmission tube, a source of direct current connected to the space current path of the rectifier, a resistive impedance connected in circuit with said source between the rectifier cathode and output electrode, a direct current voltage connection from a gain control electrode of the transmission tube to a point on said source, and a second direct current voltage connection from said electrode to a second point on said source, said second connection including a device of uni-directional conductivity and said device being connected between potential points of said resistive impedance such that the device is non-conductive for signals of a predetermined amplitude.

2. In a radio receiver, a signal transmission tube, a signal rectifier tube of the type including at least a cathode, signal grid and output electrode, a signal input circuit for said rectifier tube coupled to said transmission tube, a source of direct current connected to the space current path of the rectifier, a resistive impedance connected in circuit with said source between the rectifier cathode and output electrode, a direct current voltage connection from a gain control

electrode of the transmission tube to a point on said source, a second direct current voltage connection from said electrode to a second point on said source, said second connection including a diode device of uni-directional conductivity, and said diode device being connected in shunt across said impedance between potential points thereof such that the diode is non-conductive for signals of a predetermined intensity.

3. In a radio receiver, a signal transmission tube, a rectifier tube having a signal input circuit coupled to said transmission tube, a source of direct current connected to the space current path of the rectifier, a direct current voltage connection from a gain control electrode of the transmission tube to a point on said source, and a second direct current voltage connection from said electrode to a second point on said source, said second connection including a device of uni-

directional conductivity, said device consisting of a diode having its anode connected to said first point, and said second point being negative with respect to the first point.

4. In a radio receiver, a signal transmission tube, a rectifier tube having a signal input circuit coupled to said transmission tube, a source of direct current connected to the space current path of the rectifier, a direct current voltage connection from a gain control electrode of the transmission tube to a point on said source, a second direct current voltage connection from said electrode to a second point on said source, said second connection including a device of uni-directional conductivity, said device being a diode which has its anode connected to the rectifier cathode, and the said second point being positive relative to the first point.

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