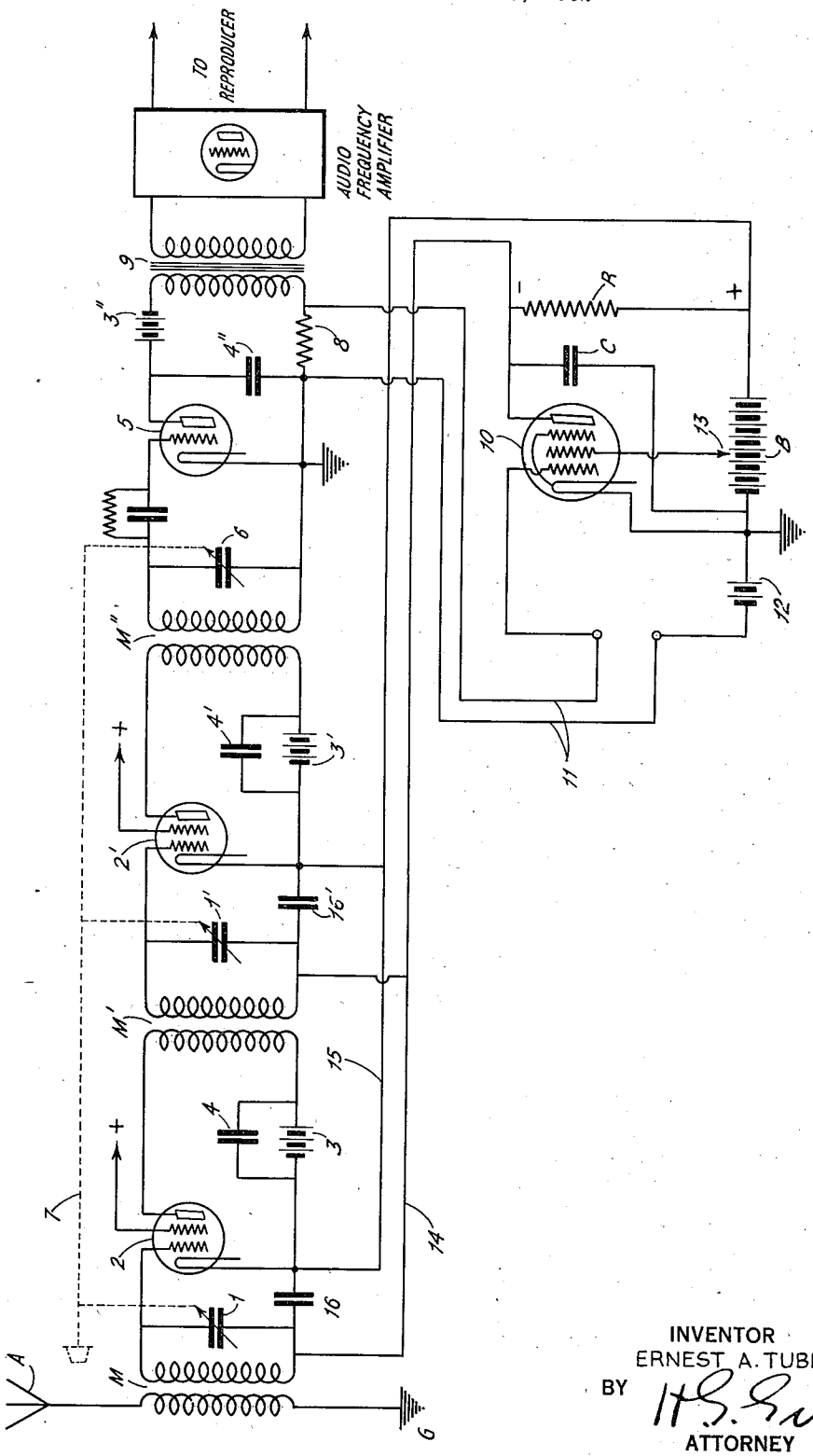
Sept. 10, 1935. E. A. TUBBS 2,013,795

AUTOMATIC VOLUME CONTROL

Filed Feb. 16, 1932



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Patented Sept. 10, 1935

2,013,795

UNITED STATES PATENT OFFICE

2,013,795

AUTOMATIC VOLUME CONTROL

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Application February 16, 1932, Serial No. 593,215

2 Claims. (Cl. 250—20)

The present invention relates to radio receiving circuits, and more particularly to a radio receiver embodying a highly efficient type of automatic gain control of economical design.

Experience with the circuit requirements of automatic volume control in a radio receiver has shown that certain limitations are present which materially add to the cost of a receiver employing such control. These limitations particularly manifest themselves in the case of portable radio receivers, and receivers of the so-called "midget" type. One of these limitations is the extra "B" supply voltage required for operating the plate of the automatic volume control tube. At the present time the total extra voltage demanded is about 135 to 150 volts.

Now, I have devised an automatic volume control circuit for a radio receiver which employs an electron discharge tube of the pentode type as the automatic volume control tube. It has been found that this tube and its associated circuit arrangements permit a high direct current translation gain with very low plate voltage thereby reducing the additional required voltage from voltage of the order of 135 to 180 volts to about voltages of the order of 50 to 57 volts. In other words, the present invention disclosing the use of a pentode tube as an automatic volume control tube results in great economy in power unit design, since, for example, it is thereby possible to employ a 300 volt supply and yet get the same automatic gain control as if the supply were raised to 450 volts, the latter voltage being necessary when a triode is employed as the automatic volume control tube.

Accordingly, it may be stated that it is one of the main objects of the present invention to provide, particularly in compact sets limited in voltage supply design, an automatic gain control circuit employing a pentode tube, which tube is comparable in expense to the usual automatic volume control triode employed in the prior art, for assuring proper automatic gain control in such compact sets, it being noted that the control voltage developed across the detector output in these compact sets is often insufficient for proper automatic volume control action when employing the usual triode tube.

Other objects of the invention are to improve generally the efficiency of the automatic gain control circuit in a radio receiver, and to particularly provide an automatic gain control circuit adapted especially for use in connection with portable and compact receivers where the voltage supply source is limited, which is not only durable and reliable in operation, but economically manufactured and installed in such receivers.

The novel features which I believe to be characteristic of my invention are set forth in particularity 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 drawing in which I have indicated diagrammatically one circuit arrangement whereby my invention may be carried into effect.

Referring now to the accompanying drawing there is shown, merely by away of illustration, a radio receiver which is to be understood as being of the portable, or compact, type. Such a receiver usually employs a grounded antenna circuit A, G which is coupled in any desired fashion, as at M, to the tunable input circuit of a first stage of radio frequency amplification.

The said tunable circuit includes a variable tuning condenser 1, and it is to be noted that the tube 2 employed in the first radio frequency amplifier stage is preferably of the screen grid type. A source of plate voltage 3 is provided between the cathode and plate of the tube 2, a radio frequency by-pass condenser 4 being connected across the source 3. A second tuned stage of radio frequency amplification is shown, the stage including a second screen grid tube 2 having a tunable input circuit, provided with a variable tuning condenser 1'. The tunable input circuit of the tube 2' is coupled, as at M', to the output circuit of tube 2. The remaining portions of the second stage of radio frequency amplification are substantially the same as corresponding portions of the first stage.

The succeeding detector stage embodies a triode 5, the grid circuit of the tube being arranged for detection by the grid rectification method. A variable tuning condenser 6 is arranged in the input circuit of the tube 5, the input circuit being coupled, as at M'' to the output circuit of the tube 2'. A uni-control tuning device 7, constructed in any desired well known fashion, is employed for simultaneously and similarly varying the rotors of the condensers 1, 1' and 6.

A source of plate potential 3'' is disposed in the anode circuit of the tube 5, the radio frequency by-pass condenser 4'' being connected between the anode and cathode of the tube 5. A resistor 8 is connected in series in the cathode-anode circuit of the detector tube, and the voltage developed across this resistor is utilized for automatic con-

trol of the gain of the radio frequency amplifier stages in a manner well known to those skilled in the art. An audio frequency amplifier, of any design, may be utilized between a reproducer (not shown) and the output of the detector stage, a coupling device 9 being utilized in this case.

The control voltage developed across the resistor disposed in the detector output is impressed between the control grid and cathode of the control tube 10, the leads 11 being utilized for this purpose. The control electrode, or grid, of tube 10 is biased to a desired direct current potential by means of a source 12. The biasing potential of this source should preferably be about 7.5 volts. The tube 10 is of the pentode type, those skilled in the art being well acquainted with the nature of such a tube, it being merely necessary in the present application to point out that the tube employs a shield, or suppressor, grid between the screen grid and the anode, the suppressor grid being connected within the tube to the cathode whereby it is maintained at cathode potential. A source of plate potential B is arranged in the cathode-plate circuit of the tube 10, a resistor R being connected between the positive terminal of the source B and the plate of tube 10.

The magnitude of the resistor R should preferably be about 750,000 ohms. A radio frequency by-pass condenser C is connected between the anode and the negative terminal of the source B, the magnitude of this condenser preferably being about 1 microfarad. A positive potential is applied to the screen of tube 10 by means of an adjustable lead 13, it being noted that the cathodes of the detector tube 5 and the control tube 10 are grounded. The leads 14 and 15 are provided to connect the output of the control tube 10 to the input circuits of the amplifier tubes 2 and 2'.

The lead 14 is conductively connected between the negative end of the resistor R and the grid of each of tubes 2 and 2', while the lead 15 is connected between the positive side of the resistor R and the cathodes of each of tubes 2 and 2'.

The operating voltage of the source B is preferably about 50 volts, while the screen grid tap 13 is adjusted to a point on the source B such that a positive potential of 20 volts is applied to the screen of tube 10.

It is believed that the operation of the present invention will be clearly understood from the aforegoing description and the following brief statement of the functions of the various elements. Assuming that the uni-control device 7 has been adjusted to a particular station setting, it will of course be understood that the radio frequency amplifier stages will deliver to the detector stage amplified radio frequency energy, and at the detected output will be amplified at audio frequency and reproduced. If for some reason the modulated carrier energy collected by the antenna circuit A, G falls below a predetermined desired level, such reduction in collected energy will be noticeable at the reproducer in a sudden diminution of volume of the receiver. The action of the control tube 10 and its associated circuits is to immediately control the amplification action of the two amplifier stages in that direction which will restore the reproducer volume to its original value prior to the currents of the carrier energy reduction. Again, if for some reason the collected carrier energy rises above the afore-mentioned desired level, the action of the control tube and its associated circuits is to immediately control the amplification of the amplifier stages in that direction which will reduce the reproducer volume to the original value. This is all accomplished in virtue of the control voltage developed across the detector output resistor 8 being impressed upon the input electrodes of the control tube 10, and the fact that the voltage developed across the resistor 8 comprises the direct current component of the rectified carrier energy. Hence, any variation in carrier results in a corresponding variation in potential developed across the resistor 8.

Should the carrier energy collected by the antenna circuit decrease below the desired level then it will be obvious that the voltage developed across the resistor 8 will decrease with the result that the effective bias on the grid of tube 10 will become more negative. This necessarily results in a decrease in voltage developed across the resistor R, and hence an effective decrease in the negative bias of the grids of tubes 2 and 2'. The radio frequency amplification of both radio frequency stages accordingly is increased, since the negative grid biases have decreased. Obviously, if the collected carrier energy rises above the desired level the reverse of the aforementioned operation will take place and the drop across the resistor R will increase with the result that the negative bias on the grids of the amplifier stages will decrease, and thereby decrease the amplification of the collected carrier energy and thus restore the volume of the reproducer to the desired level.

It will be noted that by adjusting the tap 13 of the screen grid of tube 10 it is possible to obtain a desired normal potential drop across the resistor R. That is to say, the normal bias for the grids of tubes 2 and 2' may be developed across the resistor R, and variations of the potential drop across the resistor R thereafter utilized to control the amplification of the amplifier stages as described heretofore. To do this it is merely necessary to adjust the tap 13 until the desired normal biasing voltage is secured across the resistor R. Of course, independent biasing source may be used for the grids of the tubes 2 and 2', and in that case such a biasing source would be placed in series in the lead 14. In any event, the use of the pentode tube 10 as the control tube shows two decided advantages. In the first place economy in the voltages of sources 12 and B are secured.

It will be noted that the voltages employed, and particularly the plate supply voltage of the source B, are far below that required when a triode is utilized as the control tube. In the second place, as high a direct current translation gain is secured by means of the present invention with the potential supply sources employed as is secured in the prior art with tubes costing as much as a pentode tube and using much higher supply voltages.

In the present day, the total extra voltage for operating the plate of an automatic volume control tube requires about 135 to 150 volts. The present invention reduces the additional required voltage from 135 volts to about 50 to 57 volts. The present type of pentode automatic volume control arrangement enables the use of a 300 volt supply source for the radio receiver, thus permitting great economy in the power unit design, and simultaneously permitting the same gain control action as if the supply source were of the order of 450 volts, it being pointed out that the

latter value is necessary in the prior art when the automatic volume control tube is a triode. It will be realized that this is not only of value in broadcast receivers of the non-portable type, but is particularly useful in receivers to be used in airplane installations, automobiles, and in general those types of receivers where the supply sources are limited.

In compact sets, of the so-called "midget" type, the voltage supply source is especially limited, and the control voltage developed across the detector output is often insufficient for proper automatic gain control. The use of a pentode in the gain control circuit, it being especially emphasized that the use of the pentode does not result in increased tube expense, assures proper automatic gain control in such cases.

For example, a variation of a two volt change in the input circuit of the pentode control tube is magnified as a swing of 16 volts in the output circuit of the said control tube. In receivers employing amplifier tubes of the variable mu type it is necessary to employ an automatic gain control circuit which can develop the necessary large negative potentials required in operating variable mu tubes. That is, if the tubes 2 and 2' are of the variable mu type, a type well known to those skilled in the art, a pentode control tube in the automatic gain control circuit is of particular benefit since it provides the necessary large negative potentials required for variable mu tubes, such negative potentials being of the order of 30 volts. In an actual test when the voltage impressed across the input electrodes of the tube 10 was equal to 4 volts r. m. s., the voltage available across the resistor R was 45 volts; and when the input voltage increased to 5 volts, the drop across R was equal to 49.5 volts.

Accordingly, it will be seen that the present invention lends itself very readily to the embodiment of an automatic gain control circuit in a compact radio receiver, or a radio receiver of the portable type wherein potential supply source must be conserved as much as possible, and expense of tubes employed must be maintained at a minimum.

While the present invention has been described in connection with a tuned radio frequency receiver, it is to be clearly understood that the receiver may be of the superheterodyne type, and in that case the control tube would operate upon the radio frequency amplifier tubes.

Additionally, while I have indicated and described one arrangement 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 organization 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, an amplifier circuit including an electron discharge tube, a source of signal energy coupled to the amplifier, a detector including an electron discharge tube having a resistor in its anode circuit, a pentode control tube having its grid and cathode connected across said resistor, a source of potential for the plate of said control tube having a magnitude of the order of 50 volts, a resistor connected in series between the plate of said pentode tube and the positive terminal of said potential source, means for adjustably applying a positive potential of the order of 20 volts to the screen of said pentode tube to establish the normal grid bias of said amplifier tube, and means for conductively connecting the grid and cathode of the amplifier tube to opposite terminals of said control tube resistor.

2. In a radio receiver of the midget type including a limited potential supply of the order of 300 volts, at least one radio frequency amplifier stage including a screen grid tube of the type requiring a negative grid potential of the order of 30 volts, a detector stage including a tube having its input electrodes coupled to the amplifier output, a resistor connected between the anode and cathode of the detector tube, an amplifier gain control circuit including a pentode tube provided with a screen grid and a suppressor grid, connected to said cathode within the tube, disposed between the screen grid and anode, means for connecting the control grid and cathode of the pentode tube across said resistor, means for applying a positive potential of the order of 50 volts to the pentode tube anode, a second resistor connected between the anode and said last means and having a magnitude such that a voltage drop is available thereacross of the order of 45 volts, and means for connecting the control grid and cathode of said amplifier tube across said second resistor and adjustable means for applying a positive potential to the pentode tube screen grid whereby the normal negative control grid bias of the amplifier tube may be adjusted.

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