Aug. 4, 1936. S. W. SEELEY ET AL 2,049,750

QUIET AUTOMATIC VOLUME CONTROL

Filed July 18, 1933 2 Sheets-Sheet 1

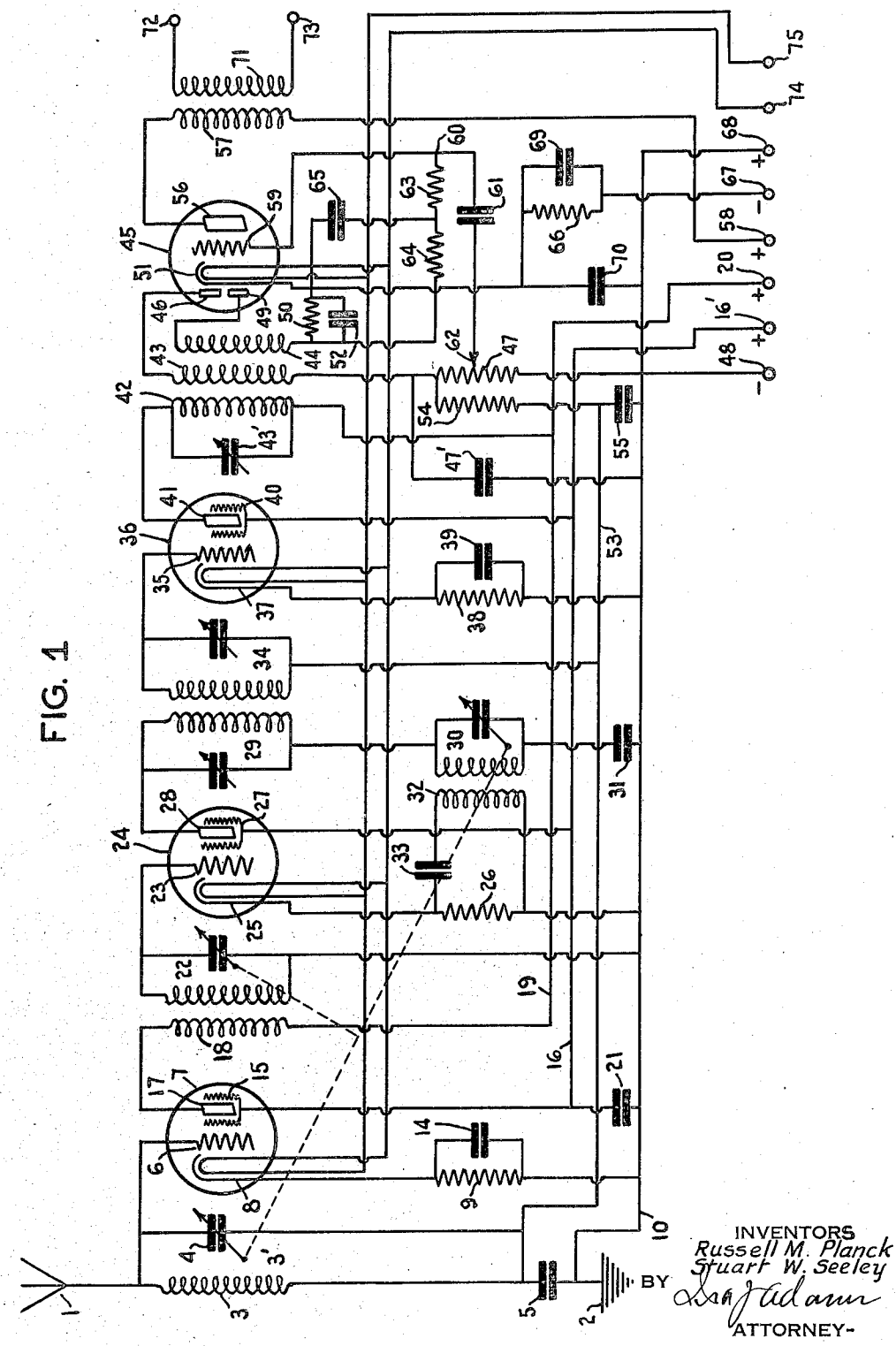


FIG. 1

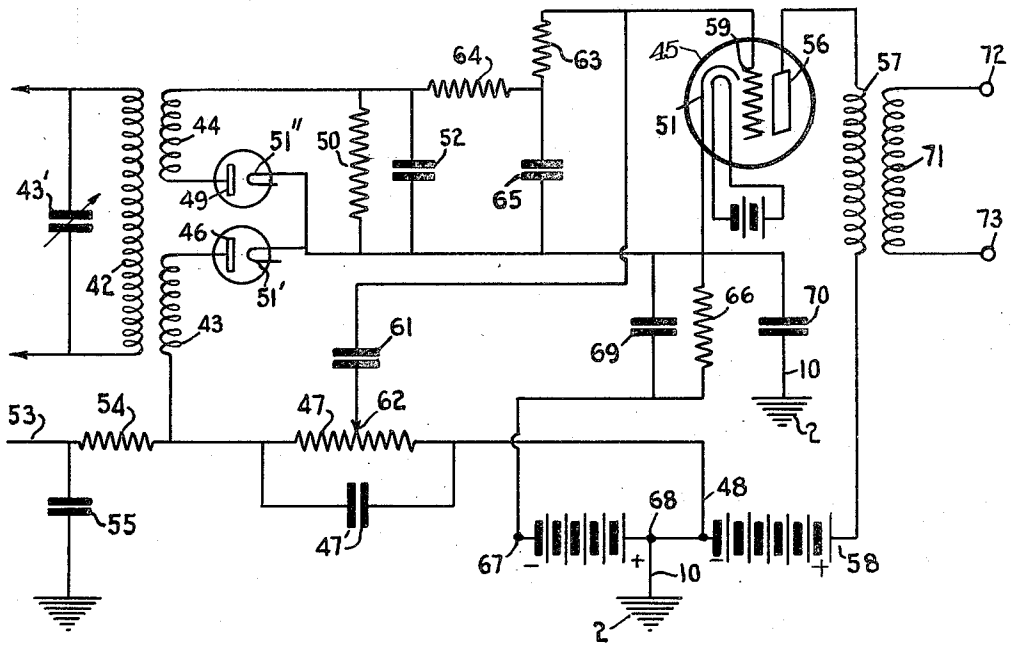
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FIG. 2



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QUIET AUTOMATIC VOLUME CONTROL

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Application July 18, 1933, Serial No. 680,912

12 Claims. (Cl. 250—20)

This invention relates to receiving sets in which automatic volume controls are employed with provisions to prevent the functioning of the sets until the carrier wave is properly tuned. Such receiving sets have what is known as "Q. A. V. C." operation. This term, as will be apparent, is an abbreviation of the phrase "quiet automatic volume control".

An object of the invention is to produce Q. A. V. C. operation with minimum number of tubes.

Another object is to produce automatic volume control with a vacuum tube that also constitutes the audio detector and amplifier.

Another object is to produce a negative bias on the control member of a vacuum tube by a diode rectifier contained in the same tube.

Another object is to produce a negative bias for automatic volume control by rectified signal current in which the alternating component has been filtered out.

Another object is to produce a negative bias on a control electrode of a vacuum tube by rectified signal current with the alternating current component removed and reduce the positive bias on a rectifier cathode by the electron current controlled by said electrode.

Other objects will appear in the following description, reference being had to the drawings in which:

Figure 1 is a schematic representation of the circuits employing the invention.

Figure 2 is a simplified illustration of the Q. A. V. C. circuits.

Referring to the drawings:

1 represents an antenna connected to ground 2 through coupling coil 3 tuned to the signal by variable condenser 4. This antenna circuit also includes blocking condenser 5 to prevent passage of the grid bias current to the ground connection 2. The grid 6 of vacuum tube 7 is connected to the tuned loop 3' and the cathode 8 of this tube is connected through biasing resistance 9 to the ground wire 10. Condenser 14 is shunted around resistance 9 to bypass the radio frequency component of the electron tube 7. Tube 7 has a screen grid 15 connected by wire 16 to some intermediate positive potential at binding post 16'. By way of example this voltage may be 67½ volts. The plate 17 of this tube is connected through transformer coil 18 and wire 19 to somewhat higher positive potential at binding post 20, say 90 volts. The screen grid 15 is connected to ground wire 10 through radio frequency bypass condenser 21.

The tuned loop 22 receives impulses from primary 18 and these are augmented by resonance in the tuned loop and applied to the grid 23 of vacuum tube 24. The cathode 25 of this tube is connected through biasing resistance 26 to the ground wire 10. The screen grid 27 of this vacuum tube is connected to the wire 16 and the binding post 16'. The plate 28 is connected through tuned loops 29 and 30 to the plate source conductor 19 and terminal 20. This conductor 19 is connected to the ground wire 10 through a radio frequency bypass condenser 31. The loop 30 is coupled for unicontrol with the tuned loops 3' and 22, as indicated. The loop 30, however, is arranged to tune either above or below in frequency, preferably above, the signal being received so as to produce a super-audible intermediate frequency. The loop 29 is tuned at the factory or at the service station to this intermediate frequency. When this is once adjusted usually no further adjustments are required. The tuned loop 39 is coupled to coil 32 shunted around resistance 26 but the shunted circuit has a blocking condenser 33 to prevent passage of direct current through this shunt. This loop 30 and the shunt 32 constitute a feed-back arrangement between the plate circuit and the grid circuit for producing oscillations. The resistance 26 contains direct current since it is in the electron circuit and the control grid or electrode 23 of the oscillator-detector tube 24 is negatively biased by the voltage across this resistance. This bias enables the oscillator tube 24 to detect the intermediate frequency caused by the reaction of the signal with the oscillator frequency and it is this detected intermediate frequency that is fed through loop 29 and the tuned loop 34 connected to the grid 35 of vacuum tube 36. The cathode 37 of this tube is connected through biasing resistance 38 to the ground wire 10. Radio frequency bypass condenser 39 is shunted around this resistance. The screen grid 40 of the tube 36 is connected through wire 16 to the positive terminal 16'. The plate 41 of tube 36 is connected to transformer coil 42 and tuning condenser 43' to the plate source conductor 19 and terminal 20.

The coil 42 is coupled to two secondary coils 43, 44. The tube 45 is a triode combined with a duplex diode for producing novel results hereinafter to be particularly referred to. The diode plate 46 is connected to coil 43 and the other end of this coil is connected through resistance 47 (which is shunted by radio frequency bypass condenser 47') to ground wire 10 which is also connected to the negative terminal 48 of the screen grid and plate voltage source. The second diode

plate 49 is connected to coil 44 and the other end of this coil is connected through resistance 50 to the cathode 51 of tube 45. An audio frequency bypass or filter condenser 52 is shunted around this resistance 50. The control grids or electrodes of tubes 7 and 36 are connected through the automatic biasing conductor 53 through resistance 54 to the negative terminal of the resistance 47. This biasing conductor 53 is connected to an audio bypass condenser 55 for filtering out any audio component in the biasing voltage. The plate 56 is connected through primary 57 to the plate voltage terminal 58 which may be a still higher positive terminal, say 180 volts. The control grid or electrode 59 is connected through audio coupling condenser 61 to an adjustable tap 62 on the resistance 47. The point 60 of this circuit is connected through resistances 63 and 64 to the negative end of resistance 50 in the diode circuit. Audio frequency filter condenser 65 is connected between the cathode 51 and to a point between the two resistances 63, 64.

The cathode 51 of tube 45 is connected so that its electron current passes through resistance 66 to the negative terminal 67 which is the negative end of a voltage supply, the positive end 68 of which is connected to ground wire 10. The voltage between the terminal 67, 68, may be some intermediate voltage such as 90 volts. Resistance 66 is shunted by audio frequency bypass condenser 69. The cathode 51 is also connected through bypass condenser 70 to ground wire 10.

The primary of the coil 57 in the plate circuit of tube 45 may be coupled through any arrangement such as coil 71 to the output terminals 72, 73, which may be connected to further audio amplifiers and a speaker. Since these form no part of the invention they are merely indicated and not shown.

The cathode heaters of all the tubes are shown as being fed from terminals 74, 75, of a direct current source.

The operation of the receiving system will now be described.

A clear understanding of the operation will be had by referring to the simplified circuit of Fig. 2 insofar as the circuits are there illustrated.

When no signal is being received there is no voltage induced in coils 43, 44. Consequently no current flows in either circuit. The absence of current in coil 44 and resistance 50 leaves the grid 59 without any negative bias. Consequently a sufficient current flows from terminal 58 through coil 57, plate 56, cathode 51, resistance 66 to negative terminal 67 to bias the anode 46 negative to the cathode 51'. Hence no current can flow in coil 43 until this cathode is reduced in potential below the anode or plate 46.

In Fig. 1 when the signal comes in from antenna 1 through the radio frequency amplifier 7 the oscillator-detector 24 and intermediate frequency amplifier 36, intermediate frequency current commences to flow at once in coil 44 (Fig. 2) through resistance 50 to cathode 51'' and thence to diode plate 49 as there is no bias between the anode and cathode in this circuit. The flow of current through resistance 50 produces a negative bias through resistances 64 and 63 on the grid 59. This reduces the electron current flowing through resistance 66 below the no-signal value until the voltage of anode 46 is equal to or above that of the cathode. The signal current then flows from coil 43 through resistance 47, terminal 68, the voltage source terminal 67, resistance 66, cathode 51' to plate 46. At this time the combination of the voltage drop in resistance 66 and the voltage between terminal 67 and 68 makes the cathode 51' at the same potential as or slightly negative to the anode 46. The signal current of the coil 43 is thus rectified. This rectified current has both a D. C. and an A. C. component. This D. C. component produces an automatic volume control bias on the grids of tubes 7 and 36 through the resistance 54 and conductor 53. The audio frequency component is kept off of the grids by resistance 54 and condenser 55. The audio frequency component in resistance 47 is impressed directly on the grid 59 through adjustable tap 62 and audio frequency coupling condenser 61, that is, there is an audio voltage drop across resistance 47. The tap 62 on this resistor being connected to grid 59, the other end returning to the cathode 51 through the voltage supply and condenser 69. The filter action of resistor 64 and condenser 65 serves to keep audio voltages which are developed across resistor 50, due to rectifying action of diode plate 49, from reaching the grid 59. The audio voltage is then amplified through variation of the plate circuit electron current and amplified impulses appear in the primary 57 and secondary 71 whence they may be further amplified and reproduced in the loud speaker not shown.

It takes a predetermined current in rectifier coil 44 to reduce the potential of the rectifier cathode 51' down to the potential of the anode 46, so that no sound is produced in the speaker (not shown) until the signal reaches the threshold value.

If the signal tends to increase, a greater bias will be produced in resistance 47 and a greater negative bias on the grids of amplifying tubes 7 and 36 which will decrease the signal down to the desired level. The volume can be set to the desired value by adjusting the slide contact 62 on the resistance 47 and when this is once set to the desired volume such volume will be maintained by the automatic features described. Since no current can be rectified thru diode plate 46 until a predetermined threshold current is produced due to the negative bias of the anode 46, side band noises, hisses and other stray effects are eliminated. No signal effects can be produced on the grid 59 until the cathode 51' is reduced in potential below the anode 46 and this can only be produced by some sufficiently strong voltage such as will be produced by a signal wave. The arrangement therefore produces what is known as Q. A. V. C. operation where nothing is heard between the various stations tuned in, the signal being only reproduced when the set is accurately in tune with the carrier wave.

It will be apparent that we may secure many features of the improvement without using the combined diode-triode tube, as separate diodes or other rectifiers may be used exactly as indicated in Fig. 2.

It will also be apparent that we may modify the arrangement so as to produce other features of the invention without combining them in such a way as to produce all of them together. In other words, we may modify the arrangement so as to produce any one of the desired features alone, though, of course we prefer to produce all of them in combination for best operation of the receiving set.

Having described our invention, what we claim is:

1. In radio receiving sets, an amplifying tube,

a rectifier connected to receive energy from said tube, a second amplifier tube connected to receive energy from said rectifier means including a second rectifier to negatively bias the anode of said rectifier by space current in the second amplifier, and means to reduce said bias to zero in response to current passing through the first mentioned amplifier above a predetermined value.

2. In radio receiving sets, an amplifying tube, a rectifier connected to receive energy from said tube, a second amplifier tube connected to receive energy from said rectifier means to negatively bias the anode of said rectifier by space current in the second amplifier, and means to reduce said bias to zero in response to current passing through the first mentioned amplifier above a predetermined value, a resistance in circuit with said rectifier, and means to apply a negative bias to the control electrode of the first mentioned tube proportional to the current flowing through said resistance.

3. In radio receiving sets, an amplifier tube, a rectifier connected to receive energy from said tube, a second amplifying tube connected to receive energy from said rectifier, a resistance in the circuit of said rectifier, a resistance in the output circuit of the second amplifier tube, means to negatively bias the anode of said rectifier from the potential drop in the second resistance, and means to negatively bias the control electrode of the first amplifying tube by the potential drop in the first resistance.

4. In radio receiving sets, an amplifier tube, a rectifier connected to receive energy from said tube, a second amplifying tube connected to receive energy from said rectifier, a resistance in the circuit of said rectifier, a resistance in the output of the second amplifier tube, means to negatively bias the anode of said rectifier from the potential drop in the second resistance, and means to negatively bias the control electrode of the first amplifying tube by the potential drop in the first resistance, a second rectifier connected to receive signal current from the first amplifier, a resistance in circuit with the second rectifier, and means to negatively bias the control electrode of the second amplifier tube by the potential drop in the third resistance.

5. In radio receiving sets, a resistance, a vacuum tube, a source of supply having high and intermediate positive voltage terminals and a common negative voltage terminal, the high positive voltage being connected to the anode of said tube and the negative voltage terminal to one end of said resistance, the other end of said resistance being connected to the cathode of said tube, a second resistance, a rectifier having its cathode connected to one end of said second resistance and to the cathode of said tube and its anode to the other end of said second resistance, a connection between said other end of the second resistance and the control electrode of said vacuum tube, a second rectifier having its cathode connected to the cathode of said vacuum tube, a third resistance connected between the anode of the second rectifier and the intermediate positive voltage terminal.

6. In radio receiving sets, a resistance, a vacuum tube, a source of supply having high and intermediate positive voltage terminals and a common negative voltage terminal, the high positive voltage terminals being connected to the anode of said tube and the negative voltage terminal to one end of said resistance, the other end of said resistance being connected to the cathode of said tube, a rectifier having its cathode connected to one end of a second resistance and to the cathode of said tube and its anode to the other end of said second resistance, a connection between said other end of the second resistance and the control electrode of said vacuum tube, a second rectifier having its cathode connected to the cathode of said vacuum tube, a third resistance connected between the anode of the second rectifier and the intermediate positive voltage terminal of the second source, and a connection between the control electrode of said tube and a point on the third resistance.

7. In radio receiving sets, a resistance, a vacuum tube, a source of supply having high and intermediate positive voltage terminals and common negative voltage terminals, the high positive voltage terminal being connected to the anode of said tube and the negative voltage terminal to one end of said resistance, the other end of said resistance being connected to the cathode of said tube, a second resistance, a rectifier having its cathode connected to one end of said second resistance and to the cathode of said tube and its anode to the other end of said second resistance, a connection between said other end of the second resistance and the control electrode of said vacuum tube, a second rectifier having its cathode connected to the cathode of said vacuum tube, a third resistance connected between the anode of the second rectifier and the intermediate positive voltage terminal, a vacuum tube amplifier, means to connect the output of said vacuum tube amplifier to both of said rectifiers and a connection between the control electrode of said vacuum tube amplifier and the negative end of the third mentioned resistance.

8. In radio receiving sets, a resistance, a vacuum tube, a source of supply having high and intermediate positive voltage terminals and common negative voltage terminals, the high positive voltage terminal being connected to the anode of said tube and the negative voltage terminal to one end of said resistance, the other end of said resistance being connected to the cathode of said tube, a second resistance, a rectifier having its cathode connected to one end of said second resistance and to the cathode of said tube and its anode to the other end of said second resistance, a connection between said other end of the second resistance and the control electrode of said vacuum tube, a second rectifier having its cathode connected to the cathode of said vacuum tube, a third resistance connected between the anode of the second rectifier and the intermediate positive voltage terminal, and a connection between the control electrode of said tube and a point in the third resistance, a vacuum tube amplifier, means to connect the output of said vacuum tube amplifier to both of said rectifiers and a connection between the control electrode of said vacuum tube amplifier and the negative end of the third resistance.

9. In systems for detecting and amplifying signals above a predetermined threshold value, a rectifier for detecting said signals having an anode and a cathode, an amplifier tube having its grid connected to receive detected signals from said rectifier, a direct current supply for the anode-cathode circuit of said amplifier tube, means to negatively bias the anode of said rectifier by a direct current potential in said anode-cathode circuit and a second rectifier adapted to negatively bias the grid of the amplifier tube

with the direct current potential of the rectified signal.

10. In systems for detecting and amplifying signals above a predetermined threshold value, a radio frequency amplifying tube for amplifying said signals, a rectifier for detecting the signals amplified by said tube and having an anode and cathode, an amplifier tube having its grid connected to receive detected signals from said detector, a direct current supply for the anode-cathode circuit of the second mentioned amplifier tube, means to negatively bias the anode of said rectifier by a direct current potential in said anode-cathode circuit and a second rectifier connected to the output of said radio frequency amplifying tube and adapted to negatively bias the grid of the second mentioned amplifier tube with the direct current potential of the rectified signal and means to bias the grid of the radio frequency amplifying tube by the direct current potential of the signal detected by the first mentioned rectifier.

11. In systems for detecting and amplifying signals above a predetermined threshold value, a rectifier for detecting said signals having an anode and a cathode, an amplifier tube having its grid connected to receive signals from said detector, a second rectifier for rectifying said signals, a resistance in circuit with said rectifier having its negative and positive ends connected respectively to the grid and cathode of said amplifying tube and a condenser adapted to substantially short-circuit the alternating current potential of said resistance.

12. In systems for detecting and amplifying signals above a predetermined threshold value, a rectifier for detecting said signals having an anode and a cathode, an amplifier tube having its grid connected to receive signals from said detector, a second rectifier for rectifying said signals, a resistance in circuit with said rectifier having its negative and positive ends connected respectively to the grid and cathode of said amplifying tube, an impedance to alternating current connected between the negative end of said resistance and the grid of said tube, and a low impedance condenser in shunt to the first resistance.

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