Dec. 12, 1939. F. B. STONE 2,183,206

RESONANCE TUNING INDICATOR SYSTEM

Filed March 28, 1936

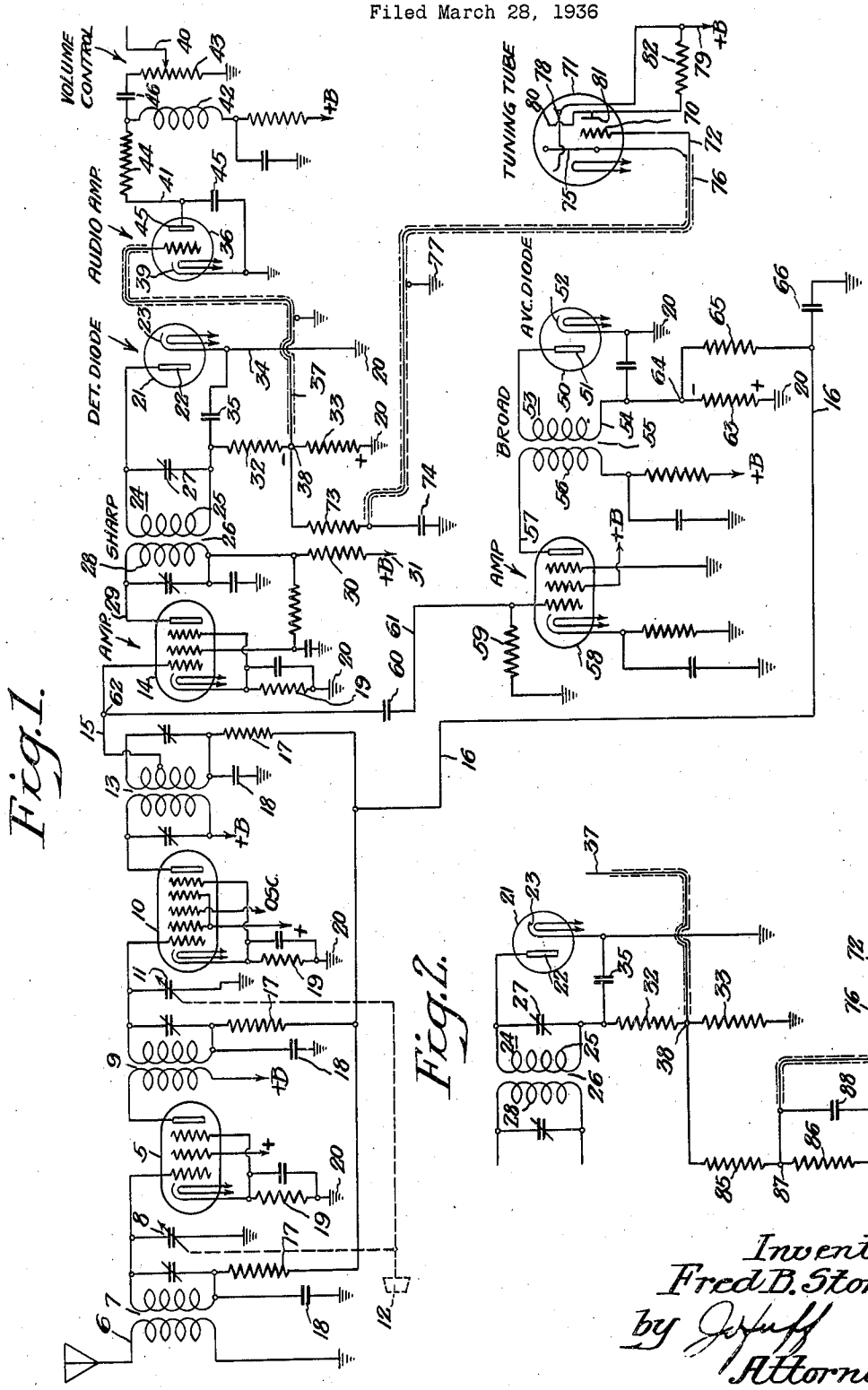


Fig. 1.

Fig. 2.

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Patented Dec. 12, 1939

2,183,206

UNITED STATES PATENT OFFICE

2,183,206

RESONANCE TUNING INDICATOR SYSTEM

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Application March 28, 1936, Serial No. 71,374

10 Claims. (Cl. 250—20)

The present invention relates to resonance tuning indicator systems, and more particularly, to a system of that character for use in connection with a superheterodyne receiver having automatic volume control means.

As is well known, it is desirable to provide automatic volume control means broadly responsive to a selected signal or carrier wave while the signal amplifying circuits are more sharply responsive thereto, to provide a predetermined degree of selectivity and to prevent interference between adjacent signal channels.

It is, therefore, an object of the present invention to provide an improved resonance tuning indicator system in connection with automatic volume control means whereby the resonance indication may be relatively sharp in its response to tuning adjustment while the automatic volume control function may be independent thereof and relatively broad in its response to the same tuning adjustment.

In a preferred embodiment of the invention, a superheterodyne receiver is provided with radio frequency and intermediate frequency amplifiers, and first and second detectors. The resonance or tuning indication is applied to a more sharply tuned signal amplifying channel, while the automatic volume control means is applied to a more broadly tuned signal amplifying channel.

It is, therefore, a further object of the present invention to provide a resonance tuning indicator system for radio receiving apparatus and the like, which includes a separate amplifying channel from the signal or modulated carrier wave amplifying channel, for the automatic volume control means, and to provide differing degrees of selectivity in the two channels.

The invention is particularly adapted for use in connection with an indicating device known on the commercial market as an RCA 6E5 tube or "Magic Eye". This is a cathode ray device operated by a control grid and having an electrode associated with the target or fluorescent screen electrode for casting a shadow thereon, the width of which varies with the potential applied to the electrode under control of the control grid.

It is, therefore, a further object of the invention to provide an improved resonance tuning indicator system wherein a tuning indicator tube of the above type is used and to provide an improved coupling circuit therefor whereby it may be applied to a sharply tuned circuit such as the output circuit of a diode second detector of a superheterodyne receiver without effecting the signal output characteristic of the detector to cause distortion of demodulated signals.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a schematic circuit diagram of a radio receiving system provided with a resonance tuning indicator system and automatic vo'ume control means embodying the invention, and

Fig. 2 is a similar schematic circuit diagram of a portion of the circuit of Fig. 1 showing a modification thereof.

Referring to Fig. 1, the radio receiving system shown is of the superheterodyne type comprising a radio frequency amplifier tube 5 coupled to a signal input circuit 6, such as an antenna circuit, through an input coupling transformer 7 tuned by a variable capacitor 8 and supplying amplified signals through a second coupling transformer 9 to a frequency converting device 10, the oscillator circuits of which are not shown for the purpose of simplifying the drawing. The transformer 9 is tuned by a second variable capacitor 11 connected with the tuning control means 12 for gang control with the capacitor 8. The oscillator tuning capacitor and circuit are not shown for reasons as stated above.

The frequency converting device 10 is coupled through a first intermediate frequency transformer 13 with an intermediate frequency amplifier tube 14, the input circuit of the amplifier 14 being indicated at 15. Automatic volume control potentials for controlling the tubes 5, 10 and 14 are applied thereto through a lead 16 and suitable filters comprising series resistors 17 and bypass capacitors 18. Each of the tubes is also provided with suitable source of fixed biasing potential for normally biasing the tubes in the absence of signals, and indicated in the present example, by the self bias resistors 19. Circuit returns are made to the chassis or ground as indicated by the ground connections 20. The usual superheterodyne type of receiver is well known and understood and, accordingly, further description is believed to be unnecessary.

The second detector is preferably of the diode type as indicated by the tube 21 and is provided with an anode 22 and a cathode 23 of the indirectly heated type. The detector is connected with a relatively sharply tuned input circuit 24 comprising the secondary 25 of an intermediate frequency coupling transformer 26 and a shunt tuning capacitor 27. The primary 28 of the transformer is connected in the plate circuit 29 of the intermediate frequency amplifier 14 in series with a limiting resistor 30 in the anode potential supply lead 31.

The detector or diode circuit includes a series filter resistor 32 and a diode output resistor 33 connected between the low potential side of the tuning input circuit 24 and ground 20, to which is also connected the cathode 23 as indicated by the

lead 34. The anode 22 is connected to the high potential side of the tuned input circuit 24.

Signals, such as a modulated carrier wave, received in response to the tuning adjustment of the tuning means 12, are rectified by the diode rectifier and the direct current and modulation components thereof appear across the output resistor 33. The resistor section 32 and a by-pass capacitor 35 to the cathode provide a filter for the intermediate frequency signals, whereby only the modulation or audio frequency component and the direct current or rectified portion of the signal appear across the output resistor section 33.

The modulation or audio frequency component of the signal is applied to an audio frequency amplifier tube 36 through a shielded lead connection 37 with the high potential end 38 of the resistor 33 and, since the cathode 39 of the amplifier is connected to ground, as indicated, the amplifier 36 is also biased by the direct current potential existing in the resistor 33 in response to signals.

The audio frequency amplifier may be coupled to any suitable output circuit such as a lead 40 through an output circuit 41 coupled thereto through an output coupling choke coil 42 and an output volume control potentiometer 43. A limiting series resistor 44 adjacent to the anode 45 of the audio frequency amplifier 46 and a suitable by-pass capacitor 45 provide a further filter for the intermediate frequency signals. The output potentiometer 43 and the output anode choke coil 42 may be coupled directly or through a coupling capacitor indicated at 46.

The above described circuit arrangement provides a relatively sharply tuned intermediate frequency coupling circuit between the intermediate frequency amplifier and the second detector, whereby the response characteristic of the receiver may be sufficient to provide a desired degree of selectivity for the reception of signals in closely spaced signal channels without reducing the fidelity of response appreciably. This fidelity of response is materially enhanced by the direct coupling of the audio frequency amplifier with the diode output resistor in such a manner that the audio frequency amplifier device is biased by the rectified signal current and receives the audio frequency component directly without the intermediary of coupling means. To this end, the audio frequency volume control is placed in a circuit succeeding the first audio frequency amplifier, as shown, thereby loading the audio frequency or diode output resistor only with the grid of the amplifier tube 36.

To provide a broader tuning response for the automatic volume control means, the same is provided with a separate signal amplifier channel from the amplifier channel for the second detector and, in the present example, comprises a second diode rectifier device 50 having anode-electrode 51 and a cathode 52 of the indirectly heated type connected with a relatively broadly tuned input circuit 53 comprising the secondary 54 of an intermediate frequency coupling transformer 55, the primary 56 of which is connected in the output circuit 57 of an intermediate frequency amplifier tube 58, similar to the amplifier tube 14, and this, in turn, is coupled with a coupling resistor 59 and a coupling capacitor 60, in a circuit 61 connected with a point 62 on the main signal channel preceding the sharply tuned circuit for the diode detector and, in the present example, a connection with the input circuit 15 of the last intermediate frequency amplifier 14.

It will be noted that the primary and secondary windings 56 and 54 of the transformer 55 for the automatic volume control diode 50 are not tuned by shunt capacitor means but are made broadly resonant to the intermediate frequency, whereby the automatic volume control diode may receive and rectify a signal slightly in advance of or succeeding the exact resonance adjustment of the tuning means 12 for any received signal. Interference between adjacent signal channels is, thereby, reduced by the response of the automatic volume control means over a wider band than the detector.

The automatic volume control diode is provided with an output resistor 63 connected through ground 20 with the cathode 52 and with the input circuit 53. Automatic volume control potentials are applied to the automatic volume control lead through an output connection 64 and a filter resistor 65 provided with a bypass capacitor 66 at the output end thereof in connection with the lead 16.

The direction of flow of current in the diode output resistor 63 is of the polarity indicated to cause the rectified signal to increase the bias potential on the grids of the tubes 5, 10 and 14 to reduce the amplification and, thereby, control the gain. The increase in biasing potential is such that the initial potential derived from the self-bias resistors 19 is increased by the amount of the bias potential generated in the output resistor 63.

From the foregoing description it will be seen that the diode detector 21 is provided with a relatively sharply tuned signal amplifying channel including the amplifier device 14 and the tuned coupling transformer 26, while the automatic volume control diode 50 is provided with a separate, relatively broadly tuned, signal amplifying channel, including the substantially untuned coupling transformer 55 for the separate amplifier device 58 coupled in parallel with the input circuit 15 of the amplifying channel for the detector.

This arrangement permits a desirable functioning of both the detector and the automatic volume control means in the presence of received signals and further permits the use of a tuning indicator in connection with the detector circuit from which may be derived a sharp tuning indication.

If such tuning indication be derived from the automatic volume control circuit in combination with the second detector circuit, it may not be made sufficiently broad for automatic volume control purposes without providing a relatively broad tuning response or relatively broad detector response.

In the present system, furthermore, the consideration of high audio frequency fidelity is important and this involves a relatively light or substantially zero load across the detector output resistor 33 and is accomplished by connecting the control grid 70 of a tuning indicator tube 71 through a shielded input lead 72 with the detector diode output resistor 33 at a suitable voltage tap point such as the point 38.

In a series with the lead 72 adjacent to the tap point is provided a relatively high resistance series path comprising a high resistance element 73, the output or grid end of which is bypassed to ground or chassis through an audio frequency bypass capacitor 74. The resistor 73 is preferably of several megohms resistance, whereby the diode output resistor 33 is substantially unloaded, and

the by-pass capacitor 74 on the grid end of said resistor is of sufficient capacity to prevent audio frequency signals from reaching the grid 70 of the tuning indicator tube 71.

In the present example, the cathode 75 of the tuning indicator tube is connected to the shield 76 for the lead 72 and this is grounded, as indicated at 77, to the chassis and common return circuit of the receiver, whereby the increased rectified potential appearing across the output resistor 33 of the sharply tuned diode is applied between the control grid and the cathode to cause the tuning indication to change in response to a received signal when tuning the receiver. The diode control circuit for the tuning indicator tube is relatively sharply tuned with respect to the diode automatic volume control circuit and the control potential applied thereto is substantially constant for all signals.

The tuning indicator tube comprises a target 78 which fluoresces when the tube is energized, and a shadow is cast thereon by an electrode 80 connected to an anode-electrode 81 associated with the control grid 70 and connected with the source of anode potential 79 through a series resistor 82. The operation is such that as the grid 70 increases in negative bias in response to a received signal, the anode current to the anode 81 through the resistor 82 is decreased, thereby bringing the electrode 80 nearer to the potential of the target 78 and decreasing the spread of electrons about the electrode 80 from the cathode 75. As the particular tube described is well known, further description is believed to be unnecessary.

An advantage of the tuning indicator and automatic volume control circuit arrangement described, lies in the fact that by providing a parallel channel automatic volume control circuit the voltage at the tuning indicator diode is substantially flat or substantially constant for all received signals as distinguished from the usual circuit in which the voltage may vary from one to 30 volts for received input potentials of from 100 microvolts to one volt.

The voltage divider circuit provided in the tuning indicator diode output circuit and, in the present example, by the resistor sections 32 and 33, are such that the proper amount of rectified voltage is delivered to the grid 70 of the tuning indicator tube to give best operation thereof over the ranges of signal strength more generally encountered and the filter means interposed between the voltage divider or diode output circuit impedance and the control grid of the tuning indicator tube, and provided by the series resistor 73 and by-pass capacitor 74 are such that the audio frequency voltage from the tuning indicator diode or signal detector are prevented from reaching the grid 70.

A further function of the filter 73—74 is to slow down the action of the tuning indicator tube so that it will not be affected by the disturbance ordinarily encountered when tuning from station to station. The time constant of this filter is made large enough so that these disturbances do not effect the tuning indicator tube but is also sufficiently low so that the action of the tuning indicator tube is not too slow for accurate tuning.

In one embodiment of my invention, the resistor sections 32 and 33 may have a resistance of 56,000 and 220,000 ohms respectively and the resistor 73 may have a resistance of 2.2 megohms with a by-pass capacitor 74 of .01 microfarad. Furthermore, the constants of the circuits should be such that the operation of the diode 21 as the second or audio frequency detector may not be impaired. That is, the tuning indicator connection should provide a relatively little or substantially no load upon the diode output circuit to cause distortion of the audio frequency signals delivered to the audio frequency amplifier 36.

With the foregoing arrangement, the deflection of the tuning indicator tube is substantially the same for all signals received and, therefore, adjustment of the tuning device 12 may be made as accurately for weak stations as for strong ones, since the automatic volume control means operates on a separate channel and provides substantially constant voltage at the tuning indicator diode or signal detector.

In receiving sytems wherein a relatively strong signal is developed at the second detector or at the diode provided for actuating the tuning indicator device, and particularly if this diode is utilized as an audio frequency detector the tuning indicator device may be connected through a circuit indicated in Fig. 2, to which attention is now directed and in which the same reference numerals are used for like circuit elements as in Fig. 1.

In Fig. 2, the diode rectifier 21 is provided with the output resistor sections 32 and 33, the former providing a filter with the capacitor 35 and the lead 37 is connected with the tap point 38 for applying audio frequency signals and biasing potentials to the succeeding amplifier tube while the tuning indicator control lead 72 is connected to the voltage supply point 38 through a voltage divider and filter means comprising a pair of series resistors or resistor sections 85 and 86 connected substantially in shunt with the output resistor 33 for the diode.

Accordingly, such resistor sections are of relatively high resistance value and, in the present example, may be of the order of several megohms each and in such ratio with respect to each other that a tap point 87 between them is at a lower potential than the point 38, whereby the circuit lead 72 receives a relatively low potential suitable for application of the control tube indicator device or tube.

A filter capacitor 88 is connected between the lead 72 and the low potential side of the diode rectifier circuit substantially in shunt with the resistor section 86 which supplies the control grid of the indicator tube. In one embodiment of the invention the resistor sections 85 and 86 when each have a resistance of 2.2 megohms and the capacitor 88 may have a capacity of .05 microfarad for use with an RCA 6E5 indicator tube.

This circuit arrangement has the advantage that potentials suitable for audio frequency amplification may be developed at the control point 38 in the diode output circuit while both a filtering and voltage dividing action may be obtained from the series connected high resistance devices 85 and 86 and the by-pass capacitor on the grid connection therefrom, the capacity of the latter being such that the grid circuit may respond to tuning indications without being subjected to audio frequency potential variations or transient disturbances that might be encountered especially while tuning the receiver.

I claim as my invention:

1. In a radio receiving system, means providing a main tunable signal channel including a signal

detector circuit, and an audio frequency amplifier connected therewith, automatic volume control means for said system including a separate signal amplifying channel more broadly responsive to signals than the detector circuit and connected with said first named channel preceding the detector, tuning indicator means having a control grid connected with the said signal detector circuit to receive at least a portion of the direct current output voltage therefrom as a biasing potential, and filter means in said grid connection for preventing the audio frequency signal component from being applied to said grid.

2. In a radio receiving system, means providing a main tunable signal channel including a diode signal detector circuit for said system and an audio frequency amplifier connected therewith, automatic volume control means for said system including a separate signal amplifying channel more broadly responsive to signals than the diode detector circuit and connected with said first named channel preceding the detector, tuning indicator means having a control grid connected with said diode detector circuit to receive at least a portion of the rectified signal output voltage therefrom, and filter means in said grid connection for preventing the audio frequency signal component from being applied to said grid.

3. A resonance tuning indicator system for radio receiving apparatus comprising in combination, a main signal amplifying channel sharply responsive to a received signal and terminating in a main signal output circuit for said apparatus, a second signal amplifying channel more broadly responsive to said signal, means for deriving automatic volume control potentials from said last named channel, and means for deriving a tuning indication from the first named channel.

4. A resonance tuning indicator system for radio receiving apparatus comprising in combination, a main signal amplifying channel sharply responsive to a received signal and terminating in a main signal output circuit for said apparatus, a second signal amplifying channel more broadly responsive to said signal, means for deriving automatic volume control potentials from said last named channel, means for deriving a direct current potential from the first named channel proportional to the signal strength, and means for deriving a tuning indication from said potential.

5. In a superheterodyne receiver, the combination of variable tuning means, means providing a signal amplifying channel terminating in two separate output circuits, one of which is more broadly responsive to signals than the other, automatic volume control means including a diode rectifier connected with the more broadly responsive circuit and controlling the signal amplifying channel, and tuning indicator means including a second diode rectifier connected with the other of said circuits, said last named means including a tuning indicator tube having a control grid and a cathode, a diode output resistor in circuit with said last named diode rectifier and means providing a potential divided tap connection for said control grid and cathode on said output resistor.

6. In a superheterodyne receiver, the combination of variable tuning means, means providing a signal amplifying channel terminating in two separate output circuits, one of which is more broadly responsive to signals than the other, automatic volume control means including a diode rectifier connected with the more broadly responsive circuit and tuning indicator means including a second diode rectifier connected with the other of said circuits, said last named means further including a diode output resistor for said diode rectifier, a tuning indicator tube having a control electrode and a cathode connected with said output resistor to receive a control potential therefrom, and a second resistor and by-pass capacitor in said connection providing a timed delay filter for said control grid and isolating means between said tube and the output resistor.

7. In a superheterodyne receiver, the combination with tuning control means therefor of a diode second detector, diode automatic volume control means controlling the signal potential applied to said detector, separate intermediate frequency amplifiers for said detector and automatic volume control means providing differing degrees of selectivity, a diode output resistor for the second detector, a voltage output resistor connected in parallel relation thereto and having a relatively high impedance with respect to said output resistor, automatic volume control circuits connected with said automatic volume control means, and a cathode ray tuning indicator tube having a control grid and a cathode connected with said voltage divider resistor, and an audio frequency filter for the grid connection of said tube.

8. In a radio receiver, the combination with automatic volume control means and the main signal detector of said receiver, of tuned amplifying means for applying signals to said detector, separate and more broadly tuned signal amplifying means for applying signals to said automatic volume control means, a tuning indicator device having a control grid connected with the said detector to receive control potentials therefrom, and means in said connection providing an audio frequency filter having a predetermined time constant.

9. In a radio receiver, the combination with automatic volume control means and the main signal detector of said receiver, of tuned amplifying means for applying signals to said detector, separate and more broadly tuned signal amplifying means for applying signals to said automatic volume control means, a tuning indicator device having a control grid connected with the said detector to receive control potentials therefrom and said connection further including an audio frequency output circuit whereby tuning indications and audio frequency output signals are supplied from said diode output resistor.

10. In a superheterodyne receiver, the combination with tuning control means therefor of a diode second detector, diode automatic volume control means controlling the signal potential applied to said detector, separate intermediate frequency amplifiers for said detector and automatic volume control means providing differing degrees of selectivity, a diode output resistor for the second detector, automatic volume control circuits connected with said automatic volume control means, and a cathode ray tuning indicator tube having a control grid and a cathode connected with said resistor, and an audio frequency filter for the grid connection of said tube.

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