Jan. 31, 1939. J. M. RIDDLE, JR 2,145,372

DETECTOR FOR RADIO RECEIVING SYSTEMS

Filed June 30, 1937

Fig. 1.

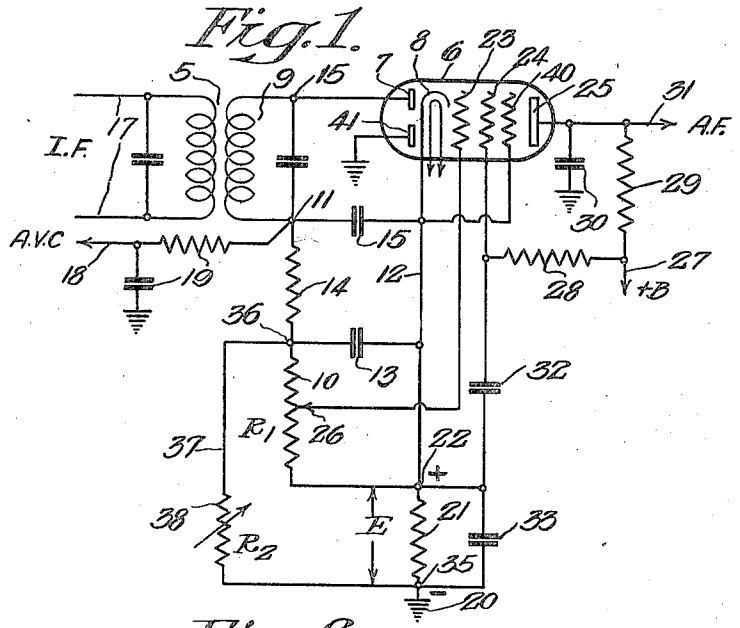
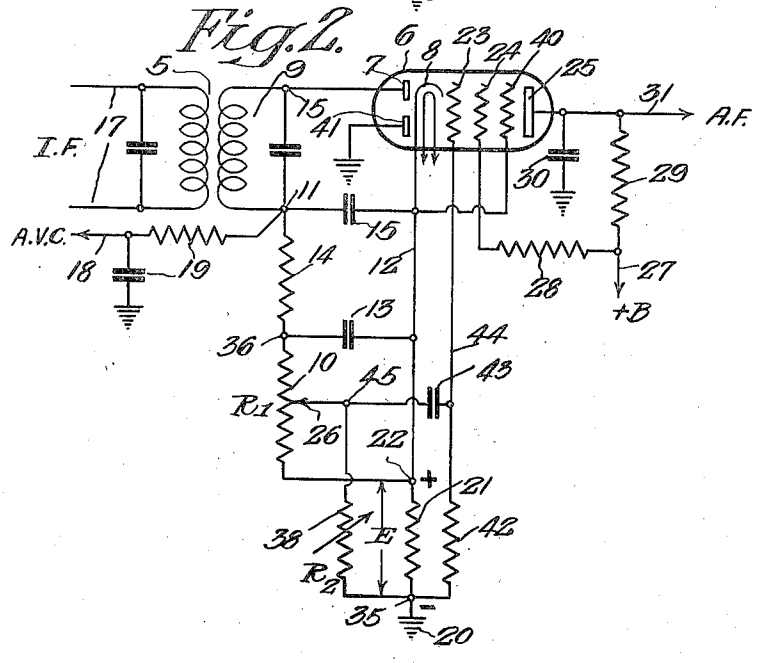


Fig. 2.



Inventor

James M. Riddle Jr.

Attorney

Patented Jan. 31, 1939 2,145,372

UNITED STATES PATENT OFFICE

2,145,372

DETECTOR FOR RADIO RECEIVING SYSTEMS

James M. Riddle, Jr., West Collingswood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application June 30, 1937, Serial No. 151,214

9 Claims. (Cl. 250—20)

The present invention relates to detectors for radio receiving systems and has for its primary object to provide an improved detector adapted to respond to signals of a predetermined strength.

More particularly, the invention relates to audio frequency detectors of the diode rectifier type and has for its further object to provide a simplified and improved delayed detection circuit in connection with the diode rectifier output circuit.

As is well understood, delayed detection of received signals prevents the reception of noise signals in tuning a radio receiver between stations, and prevents the receiver from responding to signals below a predetermined strength.

In association with a diode signal rectifier, such as a second detector of a superheterodyne receiver, a modulated signal input circuit is connected with a diode output resistor for the rectifier, across which resistor there are developed the direct current and audio frequency components of the received signal. Either or both of these components are applied to the grid of a succeeding audio frequency amplifier by connection with the output resistor.

In a preferred form of the invention, the signal rectifier or detector, and the succeeding audio frequency amplifier, may be included in the same envelope and may be provided with a common cathode. In circuit there may be provided a diode output resistor, means providing a source of fixed biasing potential, and a bias supply connection comprising three resistors in a resistance network, the arms of which bear a predetermined relation to each other, thereby to provide a predetermined delay potential on the diode rectifier anode with respect to the cathode.

It may, therefore, be considered as a further object of the present invention to provide a delayed detector circuit which includes a diode rectifier having an output resistor which is included in the delay network, thereby to simplify the delay circuit and to render it more effective in operation.

It is also a further object of the invention, to provide an improved delayed detector circuit embodying a diode rectifier and an output resistor therefor, wherein the output resistor may be provided as a volume control device operative to establish a variable delay potential in accordance with variations in the volume adjustment.

It is also a still further object of the present invention to provide a delay network for a diode signal rectifier wherein the diode output resistor may provide unitary volume control and delay potential adjustment means, operative to provide increased volume and delay potential conjointly, whereby the value of the delay potential is increased with and in proportion to volume adjustments of the volume control device for increased volume or signal output.

With a system of this character, when the volume control is reduced for low volume of signal output, additional noises are reduced thereby in tuning between stations, whereas with a higher level volume control adjustment, the noise suppression or detection delay is automatically increased, thereby to maintain the silencing or reduction of interstation noise substantially uniform regardless of the volume control adjustment.

The foregoing and other objects of the invention will be apparent from the following description of certain specific embodiments of the invention shown in the accompanying drawing, together with other features and advantages of said invention, and its scope will be pointed out in the appended claims.

In the drawing, Figure 1 is a schematic circuit diagram of the second or audio frequency detector of a superheterodyne receiver provided with a volume control and delay network embodying the invention, and

Figure 2 is a similar schematic circuit diagram of the same detector provided with a volume control and delay network embodying a modification of the invention shown in Figure 1.

Referring to Figure 1, an intermediate frequency amplifying channel is shown, by way of example, as the signal channel of a receiving system terminating in an intermediate frequency output transformer 5, by which the intermediate frequency amplifier is coupled to the second detector 6. The latter is of the diode rectifier type comprising an anode electrode 7 and a cathode 8 connected with the signal input circuit comprising the tuned secondary circuit 9 of the transformer 5.

The diode rectifier is provided with an output resistor 10 included serially between the low potential terminal 11 of the input circuit 9 and a lead 12 connected with the cathode. The output resistor is provided with a suitable intermediate frequency by-pass capacitor 13 and an intermediate frequency filter comprising a series filter resistor 14 and a second by-pass capacitor 15 to the cathode lead 12 from the terminal 11.

The input circuit may be traced from the anode 7, which is connected with the high potential terminal 15 of the input circuit 9, through the input circuit to the terminal 11, thence through the

filter resistor 14 and the output resistor 10 to the cathode lead 12 and the cathode 8.

As is well understood, modulated signals received through the intermediate frequency amplifier output leads indicated at 17 are applied to the diode rectifier 7—8 through the input circuit 9, and the direct current and audio frequency components thereof appear across the output resistor 10. Both the audio frequency and direct current components may be applied to a succeeding amplifier device by suitable connection with the output resistor.

Likewise, automatic volume control potentials provided by the direct current component of the rectified signal may be applied to the receiving system through a suitable automatic volume control lead 18 connected through a filter 19 with the terminal 11 or any suitable point on the resistor output network for the diode rectifier.

The cathode return to the chassis of the apparatus is made between the lead 12 and ground or chassis 20, and includes a cathode resistor 21, across which a potential E is established, as indicated, between the ground connection 20 and the point of connection 22 between the cathode and the rectifier output resistor 10.

In the present example, the diode rectifier 7—8 is included in the common envelope with an audio frequency amplifier having the cathode 8 in common with the diode rectifier and having a control grid 23, a screen grid 24 and an output anode 25. The output resistor 10 is arranged as a volume control resistor, having a variable contact 26, which is connected with the control grid 23, thereby to apply the audio frequency and direct current components of the rectified signal to the grid 23, the amount of which components are jointly variable by the position of the contact 26 with respect to the terminal of the output resistor 10, which is connected with the cathode at the terminal 22. The grid is therefore diode biased.

The screen grid 24 and the output anode 25 receive anode potential from a suitable supply source indicated by the positive supply lead 27, which is connected to the screen grid 24 through a supply resistor 28 and to the anode 25 through an output coupling resistor 29. The anode is also provided with a suitable intermediate frequency by-pass capacitor 30. Audio frequency signals are delivered across the resistor 29 to a suitable output circuit indicated at 31. It will also be noted that the screen grid is by-passed to the cathode through a capacitor 32 and the signal potential source represented by the resistor 21 is provided with a by-pass capacitor 33. This may be of a value only large enough to by-pass the intermediate frequency currents.

In order to provide a delay potential on the diode anode 7, i. e., a negative potential with respect to the cathode, which must be overcome by the signal potential before rectification occurs, the negative or ground terminal 35 of the potential source 21 is connected with the diode output resistor 10 at a terminal 36 forming the junction between the resistors 14 and 10, through a circuit 37 which includes a series resistor 38. The latter is preferably variable, as indicated.

With this arrangement, the diode output resistor and the series resistor 38 are connected in series across the potential source or resistor 21 to form a network between the cathode and the diode anode, of which the diode output resistor forms a part and which results in an effective tapping down on a potential source for the anode connection with respect to the cathode and to the positive terminal 22 of the fixed source.

Referring to the resistor 10 as R_1 and the series resistor 38 as R_2, the junction of the resistors R_1 and R_2 at 36 is approximately at the diode anode potential and this is lower in potential than the cathode or essentially negative with respect to the cathode by the ratio

$$\frac{R_1}{R_1+R_2}$$

thus biasing the diode negative and obtaining the effect of delayed detection. By varying the additional series resistor, the value of the delay potential may be adjusted, but in no case is it reducible to zero because of the presence of the diode output resistor in the series network comprising the resistors 10, 38 and 21.

In addition, it will be seen that an initial negative bias is also placed upon the control grid 23, which is increased as the volume control contact 26 is moved in a direction to increase the volume or signal level. The bias connection for the grid is also such that the initial potential established on the grid is in aiding relation to the bias produced by the signal rectification.

The resistor 38 is preferably relatively high in resistance value with respect to the diode output resistor 10, and in a preferred embodiment the resistor 38 may have a value variable within predetermined limits. A normal resistor value of 470,000 ohms may be provided while the output resistor 10 may have a resistance value of 250,000 ohms. With this circuit the series filter resistor 14 may have a value of 47,000 ohms and the resistor 21 may have a value of 2700 ohms. For use in connection with a tube of the type shown, which is a double diode pentode type provided by an RCA–6B7, the suppresser grid indicated at 40 is connected to the cathode and the additional diode anode indicated at 41 is connected to ground as indicated.

By providing a common cathode, a self-bias resistor as shown in the cathode lead, may be utilized as a substantially fixed source of biasing potential for the delay potential on the diode anode, and the circuit is greatly simplified in that the potential source and diode output resistor are shunted only by a single resistor, as shown, to complete the delay potential network.

In case the volume control potentiometer 10—26 is adjusted to provide a high volume output, while the resistor 38 is adjusted for the low value of delay potential on the diode anode 7, signals strong enough to overcome this delay potential in tuning between stations will be heard with loud volume and, accordingly, a modification of the circuit of Fig. 1 is proposed wherein the delay potential is automatically increased with increasing volume adjustment, as shown in Fig. 2, wherein like reference numerals refer to the same circuits and circuit elements as in Fig. 1.

Referring to Fig. 2, the combined diode rectifier and amplifier tube 6 is connected to the intermediate frequency output circuit through the transformer 5 and is provided with the same output resistor 10 and fixed biasing potential source 21 as in the preceding figure, and the tube element connections are the same except for the control grid which is provided with fixed bias from the resistor 21 through a grid resistor 42 connected between the grid 23 and the negative terminal 35 of the resistor 21. Audio frequency signals from the volume control contact 26 are applied to the grid through a coupling capacitor 43, which is connected to a lead 44 connected be-

tween the grid 23 and the resistor 42. In this manner the grid 23 is self-biased and receives only the audio frequency component of the rectified signals from the output resistor 10 of the diode rectifier 7—8. The resistor 38 additionally functions as a coupling resistor and being of high resistance value as is also the resistor 42, does not appreciably load the diode output resistor 10, even when the volume control is maximum.

In the present example, the series resistor 38 for controlling the delay potential is connected between the negative terminal 35 of the fixed source 21 and the movable contact 26 of the diode output resistor 10, as indicated at 45, whereby the amount of delay potential applied between the diode anode 7 and the cathode 8 is determined by the amount of the resistor 10 included between the contact 26 and the positive terminal 22 of the fixed source 21.

It will be seen that as the contact 26 is moved upwardly, as viewed in the drawing, to increase the volume, the effect on the delay potential is that of tapping down on the source 21 in a negative direction to increase the delay potential on the diode anode.

With this arrangement, the delay potential may be reduced to a low value when the volume control is adjusted for low signal levels and interstation noises in tuning are prevented by the fact that the volume is reduced, whereas when the volume is increased by moving the contact 26 towards the terminal 36 the delay potential is automatically increased conjointly therewith to prevent response of the system to signals causing noise when tuning between stations.

In this arrangement, the positive terminal of the means providing the fixed biasing potential is connected to the cathode of the diode rectifier, and the negative terminal of said means is connected through the series control resistor 38 to the movable volume control contact on the diode output resistor, at the low potential end of which the last named resistor is connected to the cathode of the diode rectifier and to said positive terminal.

It will be noted that when the contact 26 is substantially at the low volume end of the output resistor 10 the diode anode 7 is substantially at zero potential with respect to the cathode, whereby substantially no delay potential is applied to the diode anode, and this delay potential may be reduced to zero when the zero volume position is reached; whereas, in the circuit of Fig. 1 a zero delay potential could not be obtained because of the inclusion of the resistor 10 in the series circuit for all positions of the volume control contact 26.

For this reason, the series resistor 38 and its ratio to resistor 10 determines the total amount of delay potential available when the contact 26 is moved to the full volume control position adjacent to the terminal 36. In this position the same condition is obtained as in the circuit of Fig. 1. The resistor 38 may then be adjusted to provide a delay potential sufficient to overcome undesired signals when tuned between stations, thereby reducing noise to a minimum although the volume control contact is adjusted for maximum or relatively high volume.

From the foregoing description, it will be seen that a delay detector action may be obtained in connection with a diode signal rectifier in which the output resistor is directly connected with the cathode, as is desirable to prevent undesired coupling in the diode rectifier circuit, while at the same time a delay potential may be applied to the diode circuit through a relatively high resistance connection in shunt with the diode output resistor and a fixed potential source external to the diode rectifier circuit, and that by connecting the external source to the volume control contact on the diode output resistor, a variable delay potential may be provided conjointly with signal volume variation and in a proper direction to increase the delay potential with increased volume adjustment, thereby to maintain substantially constant the suppression of interstation response of the receiving system to noise and other undesired signals.

I claim as my invention:

1. In a radio receiving system, the combination with a diode signal rectifier having an anode and a cathode, of means providing a fixed source of biasing potential having a positive terminal connected with the cathode, a diode signal output resistor connected at one end with the cathode, means providing a direct current path between the opposite end of said output resistor and the anode, and a series resistor connected between the negative terminal of the first named means and the anode end of said output resistor, said last named resistor having a resistance substantially higher than the resistance of the diode output resistor such that a predetermined delay potential on said anode is provided.

2. In a radio receiving system, the combination with a diode signal rectifier having an anode and a cathode, of means providing a fixed source of biasing potential having a positive termnal connected with the cathode, a diode signal output resistor connected at one end with the cathode, means providing a direct current path between the opposite end of said output resistor and the anode, a volume control device providing a variable volume control connection with said output resistor, and a series resistor connected between the negative terminal of the first named means and the variable volume control connection, said last named resistor having a resistance relative to the resistance of the diode output resistor such that a delay potential on said anode is provided in accordance with volume adjustment, and substantially zero delay potential and volume may be obtained conjointly.

3. In a radio receiving system, the combination with a diode signal rectifier having an anode and a cathode, of means providing a fixed source of biasing potential having a positive terminal connected with the cathode, a diode signal output resistor connected at one end with the cathode, means providing a high impedance direct current path between the opposite end of said output resistor and the anode, a volume control device providing a variable volume control connection with said output resistor, and a series resistor connected between the negative terminal of the first named means and the variable volume control connection, said last named resistor having a resistance relative to the resistance of the diode output resistor such that a predetermined total load on the diode circuit by the diode output network and a predetermined maximum delay potential on said anode is provided, and whereby substantially zero delay potential and volume may be obtained conjointly.

4. In a radio receiving system, the combination with a diode signal rectifier having an anode and a cathode, of means providing a fixed source of biasing potential having a positive terminal con-

nected with the cathode, a diode signal output resistor connected at one end with the cathode, means providing a direct current path between the opposite end of said output resistor and the anode, a volume control device providing a variable volume control connection with said output resistor, a series resistor connected between the negative terminal of the first named means and the variable volume control connection, said last named resistor having a resistaice relative to the resistance of the diode output resistor such that a predetermined maximum delay potential on said anode is provided, a signal amplifier having a control grid and an anode associated with said cathode, means providing a signal conveying path between said control grid and said volume control connection, and means providing a signal output circuit in connection with said last named anode.

5. In a radio signal receiving system, the combination of means providing a diode signal rectifier having an anode and a cathode, a resistor in circuit with said cathode, means for causing said resistor to be traversed by anode current from said system to provide a predetermined delay potential for said rectitfier, a diode output resistor and a controlling resistor connected in series across said cathode resistor, a signal input circuit connected with said diode anode and having a low potential connection with the junction between said series connected resistors, whereby the maximum delay potential applied to said diode anode with respect to the cathode is in the ratio of

$$\frac{R_1}{R_1+R_2}$$

when R_1 equals the resistance of the diode output resistor and R_2 equals the resistance of said controlling resistor.

6. In a radio signal receiving system, the combination of an intermediate frequency amplifier output circuit, a diode rectifier device coupled to said output circuit to receive amplified signals therefrom, means for deriving the rectified direct current and audio frequency components of said signal from said rectifier including a diode rectifier output resistor and a delay potentlal supply network for said rectifier including said output resistor, a biasing potential supply element and a controlling resistor, said last named and output resistors being serially connected across said supply element, and said diode rectifier having a cathode connected between the junction of said supply element and the diode output resistor and having an anode connected at the junction between said diode output and said series controlling resistors.

7. A delayed detector for radio signal receiving systems and the like, comprising in combination, a diode rectifier device having an anode and a cathode, means for applying received signals between said anode and said cathode, a diode output resistor connected between the cathode and said last named means, means for deriving rectified signals from said resistor, means providing a source of biasing potential having a positive terminal connected with the cathode and having a negative terminal, a variable delay potential controlling resistor connected between said negative terminal and the anode end of said output resistor, and a filter resistor in circuit between said anode end of the output resistor and the signal applying means.

8. A delayed detector for radio signal receiving systems and the like, comprising in combination, a diode rectifier device having an anode and a cathode, means for applying received signals between said anode and said cathode, a diode output resistor connected between the cathode and said last named means, means for deriving rectified signals from said resistor comprising a movable volume control contact on said resistor, means providing a source of biasing potential having a positive terminal connected with the cathode and having a negative terminal, and a delay potential controlling resistor connected between said negative terminal and said movable contact, said last named resistor having a relatively high resistance with respect to the resistor of the diode output resistor, whereby the delay potential applied to said diode anode is variable conjointly with adjustment of said movable contact.

9. In a radio receiving system, the combination with a diode signal rectifier having an anode and a cathode, of means providing a fixed source of biasing potential having a positive terminal connected directly with the cathode, a diode signal output resistor connected at one end directly with the cathode, means providing a direct current path between the opposite end of said output resistor and the anode, a series resistor connected between the negative terminal of the first named means and the anode end of said output resistor, said last named resistor having a resistance substantially higher than the resistance of the diode output resistor such that a predetermined delay potential on said anode is provided, and means for varying said connection for the series resistor with the anode end of said output resistor comprising a contact movable along said output resistor toward and away from the anode end thereof.

JAMES M. RIDDLE, JR.