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TUNING METER

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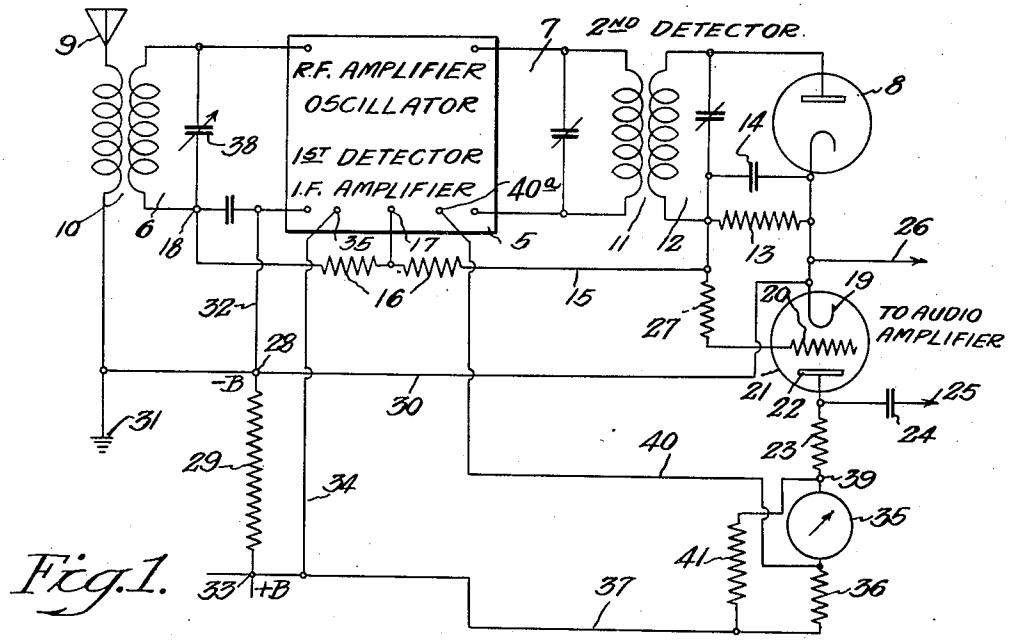


Fig. 1.

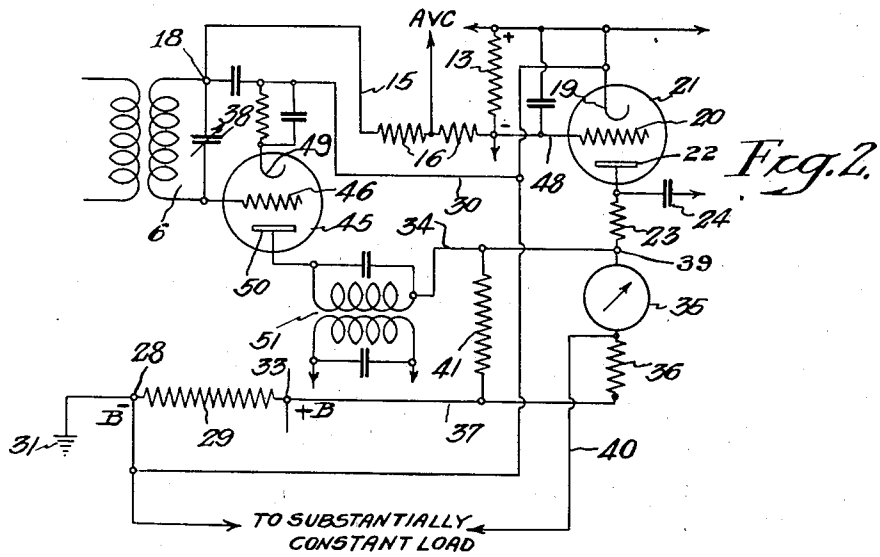


Fig. 2.

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TUNING METER

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18 Claims. (Cl. 250—40)

The present invention relates to tuning meters for radio receiving apparatus and the like, to indicate an exact condition of resonance of the tuning circuits to a received carrier wave, and more particularly, it relates to tuning indicators of the current responsive indicating type comprising an indicating meter responsive to anode current of one or more signal controlled tubes.

The present invention has for its object, to provide a tuning meter or resonance indicating device in a circuit in which the signal responsive current variations are small with respect to the normal current.

It is also an object of the present invention to provide a meter of the above character which is substantially free from the effects of potential supply variations resulting from varying load on the supply source imposed normally by operation of automatic volume control means in connection with a plurality of the amplifier tubes. As this action is simultaneous with tuning and the load, therefore, varies with the reception of a carrier wave, the resulting potential variation of a poorly regulated supply source for the receiver may be sufficient to prevent proper operation of the tuning meter at the time it is required.

For example, in radio receiving systems having a plurality of high frequency and intermediate frequency amplifier stages, the automatic volume control system, operating on the control grids of the various amplifier tubes to provide a varying bias potential and gain, may cause a widely varying plate current load on the B supply means, and, unless the latter has good regulation, the voltage of the supply may vary sufficiently and in the proper direction to counteract the tuning indication.

This is particularly true if the indication is provided by a plate current meter, such as a milliammeter, located in an amplifier plate circuit or similar circuit of the system. Such systems are well known and the tuning is effected by causing the plate current meter to swing a maximum amount in certain systems in response to increasing current, and in other systems in response to decreasing current. If the supply voltage varies at this time because of changing load, the indication may be inaccurate.

It is, therefore, a further object of the present invention to provide an improved tuning meter system embodying a plate current milliammeter as a tuning indicator, and means for preventing normal variations in B supply voltage resulting from operation of the automatic volume control system from effecting the tuning meter indication.

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, Figure 1 is a schematic circuit diagram of a radio receiving system provided with a tuning meter circuit embodying the invention, and

Fig. 2 is a similar circuit diagram of a modification of the circuit of Fig. 1, being a further embodiment of the invention.

Referring to Fig. 1, the usual circuits of a superheterodyne receiver including the radio frequency amplifier, oscillator, first detector, and intermediate frequency amplifier are indicated in the rectangle 5, to which the signal input circuit 6 is connected, and from which an intermediate frequency output circuit 7 is taken to supply a second or audio frequency detector 8, of the diode type.

The radio frequency input circuit 6 is coupled to any suitable source of signal energy, such as an antenna circuit 9 through an input transformer 10.

The intermediate frequency output circuit 7 is likewise coupled to the diode 8 through an intermediate frequency output transformer 11, in the secondary circuit of which is included the diode 8 and the diode output resistor 13. The diode output resistor is provided with a suitable intermediate frequency bypass capacitor 14.

Automatic volume control potentials derived from the output resistor 13 are applied to the amplifier 5 through an automatic volume control lead 15, and suitable filter resistors 16 connected with control terminals indicated at 17 and 18. As the operation of such systems generally is well understood, further reference thereto at this point is believed to be unnecessary.

The direct current bias and the audio frequency signals appearing across the diode output resistor 13 are applied between the cathode 19 and the control grid 20 of a first audio frequency amplifier tube 21 of the receiver through a resistor 27. Audio frequency output leads 25 and 26 are employed in conjunction with the impedance 23 and a coupling capacitor 24 to utilize the audio frequency potentials which develop between the anode 22 and the cathode 19 of the tube 21.

The cathode 19 of the audio frequency amplifier is connected to the negative terminal 28 of a source of anode potential, represented by the volt-

age divider resistor 29, through a supply lead 30, which is preferably grounded as indicated at 31. The initial stages of the receiver are also grounded through the connection 32 and connected to the negative B supply terminal 28. The positive B potential terminal is indicated at 33 and is connected to the receiver through a lead 34 and a terminal 35. The positive B supply terminal is also connected to the anode 22 of the audio frequency amplifier 21 through the output anode resistor 23, a series tuning meter 35, a voltage drop producing resistor 36 and a supply lead 37. The anode circuit for the amplifier 21 may be traced from the anode 22 through the coupling resistor 23, the meter 35 and resistor 36 through the positive supply lead 37 to the terminal 33, thence through the B supply means 29 to the negative terminal 28 and returning to the cathode 19 through the ground lead 30.

The arrangement is such that as a carrier wave is received, the second detector 8 rectifies the same and provides a biasing potential across the output resistor 13 which is applied to the receiver for automatic volume control purposes and to the amplifier 21 as a bias potential for the grid 20 which potential increases with signal strength and prevents overload. This, however, results in a reduction of the anode current and causes the meter 35 to respond. The tuning of the receiver, as by operation of a tuning capacitor 38 in the input circuit 6 exactly to the center of resonance with a carrier wave, is indicated by the tuning meter 35 in response to minimum anode current.

Assuming the current change through the anode circuit of the tube 21 or any tube chosen as the meter control tube responsive to received signals or carrier wave, to be a relatively small percentage of the normal zero-signal current, the meter may be made responsive to the current difference between a zero signal condition and full resonance to a strong carrier wave. This may be a difference of .5 milliampere in the present example, while the normal current may be 5 milliamperes. To accomplish this result, a resistor 41 is provided in shunt with the series connected meter and resistor 36. In the example given, the shunt resistor is adjusted to carry 4.5 milliamperes for a no-signal condition.

In order to maintain a substantially constant drop of potential through the series resistor 36 a supply lead 40 is connected directly with the junction of the circuit connection between the meter and the resistor 36, and is further connected to a terminal 40*a* on the receiver which causes substantially a constant current to flow through the series resistor 36.

This provides a resonance indicating system in which the deflection or indicating movement of the indicating means is responsive only to the change in current and not to the total current flowing in the control circuit. This is for the reason that the potential across the series resistor 36 is applied across the meter 35 through the shunt resistor 41, in opposition to the drop in potential through the meter.

Viewed in another way, the potential drop through the series resistor 36 and the resistance of the resistor 41 are so proportioned that with minimum current through the anode circuit of the tube 21 which corresponds to maximum carrier wave strength in the present example, substantialy no current flows through the meter 35.

The anode current in the anode circuit of the tube 21, in the absence of a carrier wave, increases to maximum which, in the example given, may be .5 milliamperes change and which change is a small percentage of the total current then flowing in the anode circuit. This small percentage of the total current flows through the indicating device causing substantially full scale deflection.

It will be noted that a common potential supply source is provided for the receiving system, the automatic volume control means, and the resonance indicating device. It has been found in certain receiving systems that the operation of the automatic volume control means causes variations in the potential supply source due to the change in load on this portion of the system which is produced by variations in negative bias potential on the tubes controlled by the automatic volume control means.

In a particular receiving system, it has been found that when a strong signal is received the potential of the supply source may increase as much as 30 volts in a supply system, the total potential of which is approximately 300 volts. An increase in potential of this nature tends to cause an increase in the anode potential of the tube 21, tending to increase the anode current, and thereby to counteract the reduction of the plate current of the tube 21 and the tuning indication above described.

To prevent this effect and to realize the advantages of the system as above mentioned, and to provide a tuning meter indication substantially free of voltage variations of the supply source in response to operation of the automatic volume control means, a tap connection is made between the meter 35 and the positive supply end of the anode resistor 23 as indicated at 39.

This modification of the circuit is shown in Fig. 2 in which the same reference numerals are used for like parts as in Fig. 1, and in which certain of the internal connections for the receiver 5 are shown for one high frequency amplifier tube 45. This may be considered as a radio frequency amplifier tube connected with the tuned circuit 6 at the input end of the receiver. The automatic volume control potential derived from the diode output resistor 13, is applied to the control grid 46 of the amplifier tube through the lead 15 and the input circuit 6, and also to control grid 20 of the amplifier device 21 through a lead 48.

The cathode 19 of the amplifier device 21 is connected through the ground lead 30 with the cathode 49 of the amplifier device 45. The source of anode potential 29 is connected with the amplifier 21 through the lead 37, the series resistor 36, the tuning meter 35, and the output coupling resistor 23. The shunt resistor 41 for the meter and series resistor is connected between the terminal 39 and the positive supply lead 37. The anode of the radio frequency amplifier 45 is indicated at 50, and is connected through a radio frequency coupling transformer 51 with the lead 34. The tube 45, the control circuit therefor and the anode circuit connection with the lead 34 may represent a series or a plurality of such tubes in the radio receiver 5.

The tuning meter system includes the anode circuit of the tube 21 wherein the anode current varies in response to a received carrier wave, and, in addition, includes the anode circuit of the amplifier tube 45 connected to a point 39 to draw current through the meter and the series and shunting resistors therefor. The second tube 45 is also controlled by the automatic volume control means, whereby as the current through the meter tends to increase in response to the in-

crease in the plate potential of the tube 21, the current through the meter is correspondingly decreased by the decrease in the plate current of tube 45 and substantially no change in current through the meter occurs due to the lack of regulation in the plate potential source. The operation of the meter in response to the increase in negative bias on the tube 21, therefore, is unaffected by the regulation of the supply source.

Summarizing the foregoing, as the automatic volume control potential increases to place a more negative potential on the grid circuits of the receiver, represented by the grid circuit 15, the plate current drawn through the lead 34 is reduced, and causes a reduction in the current through the meter 35, which counteracts the tendency to increase said current due to the higher anode potential applied to tube 21. The only change in the current through meter 35 is that produced by the change in bias on the grid of tube 21 in the plate circuit of which the meter is connected.

It may also be desirable, in connection with the system of Fig. 2, as in Fig. 1, to provide substantially constant load on the series resistor 36 for the meter whereby substantially a constant potential drop is provided therethrough, which potential drop may be applied through the resistor 41 to the negative terminal 39 of the meter. In this manner as in the preceding embodiment of the invention, the meter is responsive to the current difference and not directly responsive to the current through the anode circuit of the signal controlled tube.

I claim as my invention:

1. In a radio receiving system, a circuit providing a change in operating current in response to a received signal, which change in current is a small percentage of a predetermined normal operating value of said current in the absence of signals, a current responsive resonance indicating device in said circuit, means providing a common source of potential for said receiving system and said circuit whereby potential fluctuations resulting from changes in load on said source tend to cause a change of normal current through said circuit, and means connected in circuit with said indicating device for causing the operation thereof to be dependent only upon said first named change in current.

2. In a radio receiving system, a signal amplifier output anode circuit, providing a change in operating current in response to a received signal, a current responsive resonance indicating device in said circuit, means providing a common source of potential for said receiving system and said circuit, whereby potential fluctuations resulting from changes in load on said source tend to cause a change of normal current through said circuit, and means connected in circuit with said indicating device for causing the operation thereof to be dependent only upon said first-named change in current.

3. In a radio receiving system, a circuit providing a change in operating current in response to a received signal, which change in current is a small percentage of a predetermined normal operating value of said current in the absence of signals, a current responsive resonance indicating device in said circuit, means providing a common source of potential for said receiving system and said circuit, whereby potential fluctuations resulting from changes in load on said source tend to cause a change of normal current through said circuit, and means connected in circuit with said indicating device for applying thereto said first-named change in current to the exclusion of the normal current, whereby said indicating device is sensitive to changes in the resonance adjustment of said receiving system.

4. In a radio receiving system, the combination of a resonance indicating device, a common potential supply source for said system and said indicating device, said device being responsive both to received signals and variations in the potential of the supply source, and means connected in circuit with said device for rendering said device substantially independent of said poential supply source variations.

5. In a radio receiving system, the combination of a resonance indicating device, a common potential supply source for said system and said indicating device, said device being responsive both to received signals and variations in the potential of the supply source, means connected in circuit with said device for rendering said device substantially independent of said potential supply source variations, said last named means comprising a series resistor for and in circuit with said indicating device, a shunt resistor connected across said series resistor and indicating device, a circuit providing a change in current in response to a received signal in which said first named resistor and indicating device are connected in series, a circuit connected with the series resistor for maintaining substantially a constant potential thereacross, and a circuit connected to receive a potential through the meter providing a variable load for said circuit responsive to a received signal to cause a decrease in the load current in response to an increase in the potential of the supply source.

6. In a radio receiving system, the combination with variable tuning means therefor, of an electric discharge device having an output anode circuit, means connected therewith for causing said anode current to vary in response to a received signal, a current responsive indicating device in said circuit, means providing substantially a constant potential drop in said circuit adjacent to the positive terminal of said indicating device, and means for applying a potential from the positive end of said potential drop producing means to the negative terminal of said meter.

7. In a radio receiving system, the combination with variable tuning means therefor, of an electric discharge device having an output anode circuit, means connected therewith for causing said anode current to vary in response to a received signal, a current responsive indicating device in said circuit, means in said system for causing the anode potential supply therefor to vary in response to received signals including automatic volume control means, and means for preventing the tuning indications of said indicating device from being disturbed by operation of said automatic volume control means, comprising an anode circuit connected with the negative terminal of said meter through which the current changes in response to operation of the automatic volume control means, the anode current to the variable load decreasing by automatic volume control action as the supply potential increases, whereby the indicating device is responsive only to signal potentials applied to said first named tube.

8. In a radio receiving system, the combination with variable tuning means therefor, of an electric discharge device having an output anode, means connected therewith for causing the anode

current of said tube to vary in response to a received signal, said last named means including a diode signal rectifier coupled to said electric discharge device to apply a controlling biasing potential thereto, an output anode circuit for said electric discharge device comprising a coupling impedance, a current responsive indicating meter, and a series resistor connected in the order named from the anode, anode potential supply means connected with said circuit the output potential of which supply means varies in response to received signals, automatic volume control means having connections for causing said variation in potential, and means for permitting the current indications of said meter to be directly responsive to variations in the strength of a received signal applied to said electric discharge device substantially independently of said variation in potential, said last named means comprising a variable load circuit connected at a point between the meter and the coupling impedance to draw current therefrom which varies in response to automatic volume control action in opposition to the effect of said variation in potential on said indicating meter.

9. A tuning indication system in accordance with claim 8, further characterized by the fact that a substantially constant load circuit is connected with the output anode circuit between the meter and said series resistor, and that a shunt potential supply resistor is provided across said series resistor and the meter.

10. In a radio tuning indicator system, a tuning meter responsive to variations in anode current, an electric discharge amplifier device providing said anode current, means for applying a controlling potential thereto in response to a received carrier wave, means for variably loading the meter circuit in connection with the negative terminal thereof in accordance with variations in an anode supply potential, means for causing said variable load current to decrease in response to an increased anode potential, means providing a source of substantially fixed potential in series with said meter, and means for connecting the positive terminal of said last named source to the negative terminal of said meter, said last named means including a potential supply resistor shunting said meter and said potential source.

11. A tuning indication system, in accordance with claim 10, further characterized by the fact that a substantially constant load is provided in connection with said potential supply source.

12. In a radio receiving system, a tuning indicator comprising in combination, a diode signal rectifier, an electric discharge amplifier connected with said rectifier to receive biasing and signal potentials therefrom and having an anode circuit, an anode output coupling resistor in said circuit, a current responsive tuning indicator and series resistor therefor in said anode circuit, a potential supply resistor connected in shunt to said meter and said series resistor, a second electric discharge device having an anode circuit connected to said first named anode circuit between the meter and the said output coupling resistor, and means for applying automatic control potentials to said last named amplifier device.

13. In a radio receiver having automatic volume control means and potential supply means, the regulation of which is affected by operation of said automatic volume control means, a tuning meter system comprising an electric discharge amplifier device having an anode circuit, an output coupling impedance in said circuit, an audio frequency detector for supplying signal and biasing potentials thereto, whereby the anode current thereof varies in accordance with the strength of a received signal wave, a current responsive indicating meter in the anode circuit of said amplifier device in series with the output coupling impedance for said first-named amplifier device, a potential drop producing resistor connected between said meter and the potential supply source, a resistor connected in shunt relation to said meter and said last named resistor in series, at least one high frequency electric discharge amplifier device having an anode circuit connected to the negative terminal of said indicating meter, and means for applying automatic volume control potentials to said last named amplifier to vary the anode current thereof in response to signal strength variations.

14. In a superheterodyne receiver, a tuning meter system comprising, in combination, a second detector of the diode type, an audio frequency amplifier device directly coupled thereto to receive signal and biasing potentials therefrom and having an anode output coupling resistor, a tuning meter and a series resistor therefor connected in circuit with said anode resistor, and circuit means for supplying anode current to at least one other amplifier device in said receiver through said series resistor and tuning meter, said second amplifier being responsive to automatic volume control potentials.

15. In a superheterodyne receiver, a tuning meter system comprising, in combination, a second detector of the diode type, an audio frequency amplifier device directly coupled thereto to receive signal and biasing potentials therefrom and having an anode output coupling resistor, a tuning meter and a series resistor therefor connected in circuit with said anode resistor, circuit means for supplying anode current to at least one other amplifier device in said receiver through said series resistor and tuning meter, said second amplifier being responsive to automatic volume control potentials, and a resistor connected in shunt to said series resistor and tuning meter for applying to said meter an opposing potential in response to variations in anode potential supply, whereby said meter provides an indication of current change.

16. In a radio receiver having automatic volume control means and a potential supply system responsive to anode current load variations, the combination of variable tuning means for said receiver, a signal amplifier device responsive to a received carrier wave to provide a current variation, a tuning indicator device connected in circuit with said amplifier and said potential supply system to respond to said current variation, and means for preventing potential supply variations from changing the effect of said current variations on said indicator device, comprising a potential drop producing circuit element in series with said indicator and variable load means responsive to the operation of the automatic volume control means connected in circuit with said indicator device and said circuit element to draw load current therethrough.

17. A system in accordance with claim 16, further characterized by the fact that the series element is provided with substantially constant load and a regulating resistor is provided in shunt to said element and the indicating device in series between a positive potential point on said element and the negative terminal of the indicating device.

18. In a radio receiver having automatic volume control means and a plurality of amplifier tubes controlled thereby, the combination of a variable load circuit for supplying anode current to said tubes, a tuning meter responsive to variations in current in said circuit, a diode audio frequency detector, a direct connected amplifier device for receiving audio frequency and biasing potentials from said detector, said amplifier device having an output anode impedance connected with said meter, and means for regulating the potential on said meter to compensate for variations in load drawn by said load circuit, comprising a series regulating resistor, and a shunt regulating resistor connected across said first-named resistor and said meter in series.

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