

May 19, 1936.

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2,040,955

AUTOMATIC VOLUME AND FIDELITY CONTROL

Filed Sept. 29, 1932

Fig. 1

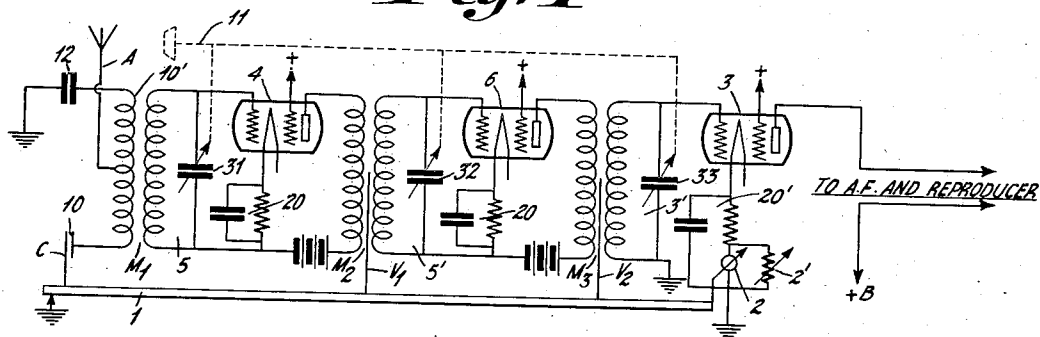


Fig. 2

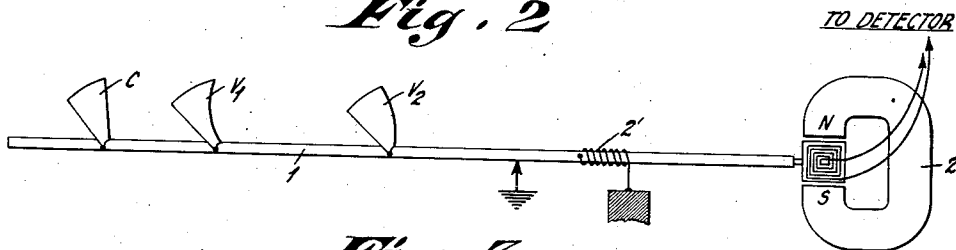


Fig. 3

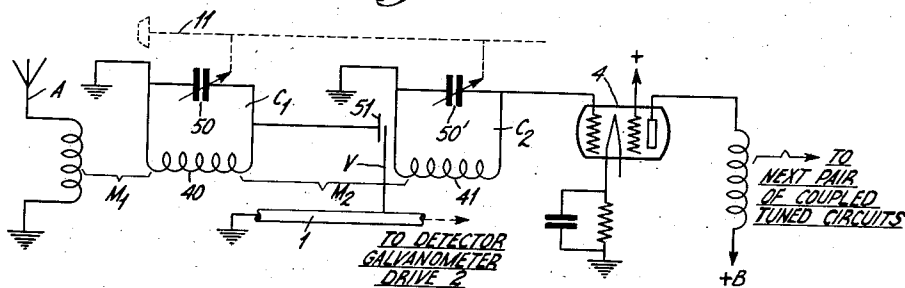
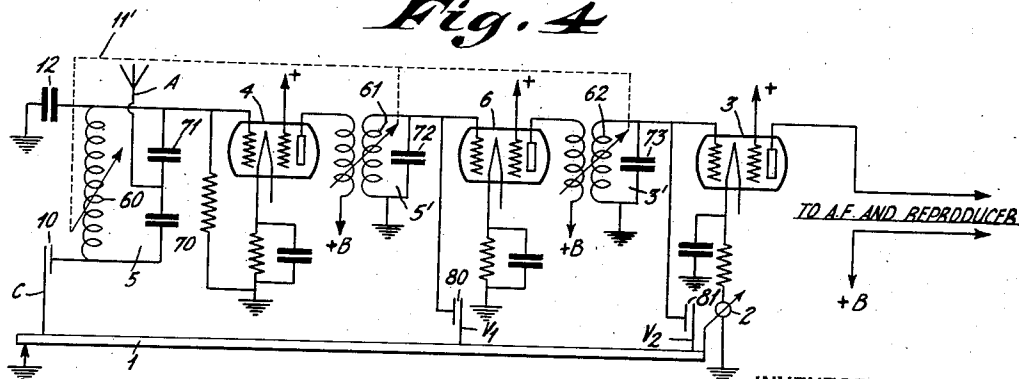


Fig. 4



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2,040,955

AUTOMATIC VOLUME AND FIDELITY
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Application September 29, 1932, Serial No. 635,371

14 Claims. (Cl. 250—20)

My present invention relates to radio receiver control devices, and more particularly to novel arrangements for automatically regulating the volume and fidelity of a receiver.

One of the main objects of my present invention is to provide an improved automatic volume control for a radio receiver in combination with a fidelity control operated by the same mechanism that accomplishes the automatic volume control.

Another important object is to provide a single automatically operating means for decreasing the amplification of a radio receiver as the signal strength increases and simultaneously increasing the fidelity, or accepted band width, of the radio circuits as the amplification is decreased.

Another object of the invention is to provide in a broadcast receiver, an automatic volume control device which insures that not more than a predetermined voltage is impressed upon the detector even in the case of the strongest signals, and that this predetermined voltage is maintained at the detector even in the presence of very much weaker signals, and an automatic fidelity control device which insures that in the presence of the strongest signals the fidelity of the receiver is such that all frequencies within the transmitted band are passed therethrough with substantial uniformity, while in the presence of weak signals which are ordinarily accompanied by static, or other interference of appreciable relative strength, the fidelity, or accepted band width, is reduced to as small a value as will allow a reasonable understandability. The advantage of this automatic variation of fidelity is that in the presence of strong signals, when great selectivity is not required to avoid static or other interference, the fidelity is high and the faithfulness of reproduction of the signals is a maximum, while, in the case of weak signals, the best compromise is achieved between good fidelity on the one hand, with attending interference due to lack of selectivity, and low fidelity on the other hand with lessened interference.

A further object of the invention is to provide an automatic volume control arrangement which varies both the input voltage to the first tube and the amplification of the subsequent stage whereby it is possible to prevent overloading the first tube by extremely strong signals on the one hand, which would occur if only the tube amplification were varied, and to avoid tube noises on the other hand which would be noticeable if the tube amplification were maintained always at maximum

and the volume control accomplished exclusively by controlling the signal input to the first tube.

A still further object is to provide an automatic volume control arrangement which definitely prevents the input to the detector from exceeding a given voltage by providing means for reducing the over-all gain between antenna and detector to zero at the predetermined detector input voltage which is not to be exceeded.

And still another object is to perform simultaneously control of volume and fidelity of a receiver by means of a single metallic body of unvarying potential.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawing,

Fig. 1 diagrammatically shows a receiver circuit embodying the present invention,

Fig. 2 shows the construction of the control shaft of Fig. 1,

Fig. 3 shows a modified form of the invention,

Fig. 4 diagrammatically shows a receiver employing still another modification.

Referring to the drawing, wherein like reference characters in the different figures represent similar circuit elements, Fig. 1 shows an embodiment of the invention wherein a grounded metal shaft 1 actuated by a galvanometer type of motor mechanism 2 located in the plate-cathode circuit of the detector 3, simultaneously changes the coupling between the antenna circuit A and the input circuit 5 of the first amplifier tube 4, and the relative tuning of the amplifier stages. To understand the system of Fig. 1, let us suppose that in the absence of any signals, or in the presence of extremely weak signals, the current through the galvanometer mechanism 2 and the return spring 2' of the mechanism (see Fig. 2) combine to so locate the angular position of the shaft 1 that the vanes V₁ and V₂ are removed from the vicinity of their associated tuned circuits 5', 3' while rotor vane C is well separated from the cooperating electrode of the variable capacity 10 in the antenna circuit A. Under these conditions the antenna circuit is most strongly coupled to the first tuned grid circuit 5, and the various tuned grid circuits 5, 5', 3' are

all tuned to the same frequency, with the result that signals are amplified to the greatest possible extent, and the selectivity is as great as possible.

Now, suppose, that a very strong signal is tuned in by the uni-control mechanism 11. The direct current component of the detector plate current changes, as is well known in the art, and causes the shaft 1 to rotate, thus moving rotor C to a position which makes the variable capacity 10 almost great enough to establish a Wheatstone bridge balance between the conjugate circuits, namely the antenna circuit A and grid input circuit 5. In the meanwhile vanes V₁ and V₂ move into the magnetic fields of their respective associated tuned circuits, thus changing the resonant frequency of these circuits by reducing the effective inductances of the coils adjacent them.

Preferably, and as shown in Fig. 2, the shapes of vanes V₁ and V₂ are different, so that their associated circuits are detuned by different amounts. This detuning results in a lesser value of amplification, while the approaching balance of the Wheatstone bridge type antenna coupling reduces the proportion of antenna voltage applied to the first tube 4, so that the over-all gain of the system is very greatly reduced. Meanwhile, without the addition of any new parts, the fidelity has been improved by the relative detuning of the various circuits. It will be seen that there will be a certain voltage input to the detector which will result in turning the shaft 1 so far that the antenna circuit A is completely uncoupled from the first tube 4.

When this occurs it is obvious that no signals will reach the detector 3. Therefore it is impossible for signal voltages applied to the detector to reach this value, and hence impossible for the detector to be overloaded. There is, however, one possible source of trouble which must be avoided, namely: that through mechanical inertia the rotor C might move beyond this balance position in which case further motion would increase the voltage supplied to the first tube 4 and reverse the volume control action. To avoid this, sufficient electrical, or mechanical, damping is preferably added to the moving system to make it dead beat or overdamped. In the present state of the art it is within the province of those skilled in this art to shape the vanes V₁ and V₂ in such fashion as to produce any desired characteristic variation of band width with signal strength. It is also obvious that the vanes may produce detuning effects by varying the grid to ground capacity; that is, by acting as vernier condensers in parallel with the tuning condensers.

The tube circuits have not been described in detail since they are too well known to require description. Briefly, the tubes 4, 6, 3 are shown as screen grid tubes, other tubes being of course adapted for such use; the usual grid bias networks 20 provide the necessary amplifier grid bias; and the network 20' biases the tube 3 to operate as a detector. The couplings M₁, M₂, M₃ are shown as transformers, the secondaries of which are disposed in tuned grid circuits. The tuning condensers 31, 32, 33 are uni-controlled by the device 11, the opposite terminals of coil 10' are connected to the capacity 10 and condenser 12, the antenna A being connected to the junction of the connection between the latter condensers. The details of the shaft 1 and its drive mechanism 2 are shown in Fig. 2. The galvanometer 2 is of any type well known in the art, and the construction is believed to be suffi-

ciently simple to be understood by those skilled in the art without further description.

Fig. 3 shows a modified embodiment of the invention wherein coupled tuned circuits are used in pairs. In this case the circuits are adjusted for approximately optimum coupling and similar tuning when the signals are very weak, thus giving substantially maximum amplification and high selectivity to the entire system. For this modification, only the arrangement between the antenna A and the first tube 4 is shown, it being understood that the same arrangement is employed between tubes 4 and 6 of Fig. 1, and between tubes 6 and 3 of the latter. Thus, antenna A is coupled, as at M₁, to the coil 40 of the tuned circuit C₁, the coil 40 being coupled, as at M₂, to the coil 41 of the tuned circuit C₂.

Tuning condensers 50, 50' are connected across coils 40 and 41 respectively, the uni-control device 11 being understood to connect all the tuning condenser rotors. One side of coil 40 is grounded, and the other side has connected to it an electrode 51. The side of coil 41 adjacent electrode 51 is grounded, while the other side is connected to the grid of screen grid amplifier tube 4. The grounded shaft 1 (connected to be actuated by the drive mechanism 2 shown in Figs. 1 and 2) carries a vane V adapted to cooperate with electrode 51. It should be understood that shaft 1 carries additional vanes for cooperation with other electrodes 51 disposed between tuned circuits as described above.

As the signals become stronger in the arrangement of Fig. 3, the control shaft 1 rotates so that vane V approaches electrode 51, and thus increases the capacity across the first tuned circuit of each pair and lowers its natural period, while the presence of conducting vane V in the magnetic field of the coil of the second tuned circuit of each pair reduces its inductance, and thus increases its natural frequency. Furthermore, the interposition of vanes V between the coils of each pair of tuned circuits reduces the effective coupling between them. Thus fidelity is improved by the relative detuning of the circuits in each pair, while amplification is decreased both by the relative detuning and by the reduction of coupling. It will be seen that, as in Fig. 1, the automatic volume control is effected both by reducing the input to the first tube, and also the subsequent amplification.

Fig. 4 shows substantially the same arrangement as Fig. 1, but applies to the case where the tuned circuits 5, 5', 3' are tuned by variable inductances 60, 61, 62 rather than by variable capacities. In Fig. 4 the bridge balance between the antenna circuit A and the grid of tube 4 is varied by vane C as in Fig. 1, but the detuning of the subsequent tuned circuits by vanes V₁ and V₂ is accomplished by utilizing these vanes to vary the capacity across the tuned circuits as suggested in connection with Fig. 1 as an alternative arrangement. Each tuned circuit includes a variable tuning inductance and shunt fixed capacity. Thus circuit 5 includes the variable inductance 60 shunted by the series condensers 70, 71. The circuit 5' includes the variable inductance 61, coupled to the output of tube 4, shunted by the condenser 72, and variable coil 62 is shunted by condenser 73. Uni-control device 11' furnishes means for simultaneous variation of the variable inductances.

Vanes V₁ and V₂ cooperate with electrodes 80, 81 respectively connected to the grids of tubes 6 and 3. Since the shaft 1 is grounded, the ca-

capacity between each of electrodes 80 and 81 and its associated one of vanes V_1 and V_2 is connected in shunt with its respective one of condensers 72 and 73. Thus, variation of the angular position of shaft 1 results in adjustment of coupling condenser 10, and variation of the tuning of circuits 5' and 3'.

In addition to the combined volume and fidelity control which has been described, a manual adjustment is preferably provided which allows the output level of the loudspeaker to be adjusted to a desired value without interfering in any way with the action of the automatic volume and fidelity control. Such a manual adjustment is most readily provided in the coupling to the last audio tube and may be of the type described in Arnold Patent 1,520,994. Preferably, however, this manual control will be arranged to affect tone as well as volume so that at high output levels there will be a lesser proportion of low frequency energy than at low levels.

Finally, in case it is desired to make the action of the combined automatic volume and fidelity control less pronounced, a variable resistance 2' is provided in shunt with motor element 2 in Fig. 1. When this resistance is set to a high value or open circuited, the automatic control action is most rapid, but when this resistance is reduced, current is shunted away from motor element 2 and the control is weakened and at the same time the maximum voltage that is allowed to reach the detector is increased.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. A combined volume and selectivity control for a receiver, the receiver including an antenna circuit, an amplifier coupled thereto, and a detector coupled to the amplifier, said control comprising means for varying the energy transfer from the antenna to the amplifier, means for regulating the amplification of signals, and electro-mechanical means, responsive to detector output variations, to control both said means.

2. A combined volume and selectivity control for a receiver, the receiver including an antenna circuit, an amplifier coupled thereto, and a detector coupled to the amplifier through a tuned network, said control comprising means for varying the energy transfer from the antenna to the amplifier, means for regulating the transmission of signals to the detector by varying the resonant frequency of said tuned network and means, responsive to detector output variations, to control both said means, said antenna circuit consisting of a bridge circuit arranged to set a definite upper limit to the detector input.

3. A combined volume and selectivity control for a receiver, the receiver including an antenna circuit, an amplifier coupled thereto, and a detector coupled to the amplifier, said control comprising means for varying the energy transfer from the antenna to the amplifier, means for regulating the amplification of signals, and galvanometer operated means, responsive to detector output variations, to control both said means.

4. A combined volume and selectivity control for a receiver, the receiver including an antenna

circuit, an amplifier coupled thereto, and a detector coupled to the amplifier, said control comprising means for varying the energy transfer from the antenna to the amplifier, means for regulating the amplification of signals, and means including a single rigid body at an unvarying potential, responsive to detector output variations, to control both said means.

5. A combined fidelity and volume control for a receiver including a signal input circuit and a translating device having a resonant input network, said control comprising means responsive to said device for controlling the fidelity of the receiver by varying the resonant frequency of said network, and other means for regulating the signal transmission between the signal input circuit and the device, said fidelity control means being designed to give a predetermined variation of fidelity with signal strength.

6. A radio receiver of the type including a signal input circuit, a tunable amplifier coupled thereto and a rectifier characterized by the fact that said receiver additionally includes means for simultaneously uncoupling the amplifier from the signal input circuit and detuning the amplifier from a predetermined resonant frequency, said means being responsive to predetermined rectifier output fluctuations.

7. In combination with a source of signals, a resonant circuit including a tuning means, a second resonant circuit including tuning means, said circuits being magnetically coupled, a metallic electrode connected to one of the circuits, a second metallic electrode, means for moving said second electrode into capacity coupling relation with the first electrode and into the magnetic coupling field between the two circuits, and means for regulating the moving means in response to variations in amplitude of said signals.

8. An electrical wave transmission system of the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination a bridge circuit means provided with a variable capacity for regulating the transfer of wave energy from the collector to said network, a second means for regulating the wave energy input to said rectifier, and a means, responsive to said potential variations, for adjusting the operation of said first and second means.

9. An electrical wave transmission system of the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination condensive means for regulating the transfer of wave energy from the collector to said network, a second means for regulating the wave energy input to said rectifier, and a means, responsive to said potential variations, for adjusting the operation of said first and second means.

10. An electrical wave transmission system of the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination means for regulating the transfer of wave energy from the collector to said network, a second means including a condenser for regulating the wave energy input to said rectifier, and a means, re-

sponsive to said potential variations, for adjusting the operation of said first and second means.

11. An electrical wave transmission system of the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination means for regulating the transfer of wave energy from the collector to said network, a second means for regulating the wave energy input to said rectifier, and a common galvanometer operated shaft means, responsive to said potential variations, for adjusting the operation of said first and second means.

12. An electrical wave transmission system of the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination means for regulating the transfer of wave energy from the collector to said network, a second means for regulating the wave energy input to said rectifier by adjusting the selectivity of the repeater output circuit, and a means, responsive to said potential variations, for adjusting the operation of said first and second means in overlapping relation.

13. An electrical wave transmission system of

the type including a wave collector, a repeater, a tuned network coupling the collector and repeater, and a rectifier adapted to convert collected wave energy into direct current potential variations, including in combination means for regulating the transfer of wave energy from the collector to said network, a second means for regulating the wave energy input to said rectifier by adjusting the selectivity of the repeater output circuit, and a means, responsive to said potential variations, for adjusting the operation of said first and second means in overlapping relation and in the same direction.

14. In a radio receiver provided with at least a rectifier having a circuit tuned to a desired signal frequency, a signal transmission network coupled to said resonant input circuit, said network including at least one resonant circuit tuned to said desired frequency, means for adjusting the amplitude of signals transmitted through said network and impressed on said rectifier input circuit by regulating the signal input to said network, means for adjusting the degree of selectivity of said network by varying the resonant frequency of said one resonant circuit, and means, responsive to variations in the direct current component of rectified signal energy for simultaneously actuating said amplitude and selectivity adjusting means.

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