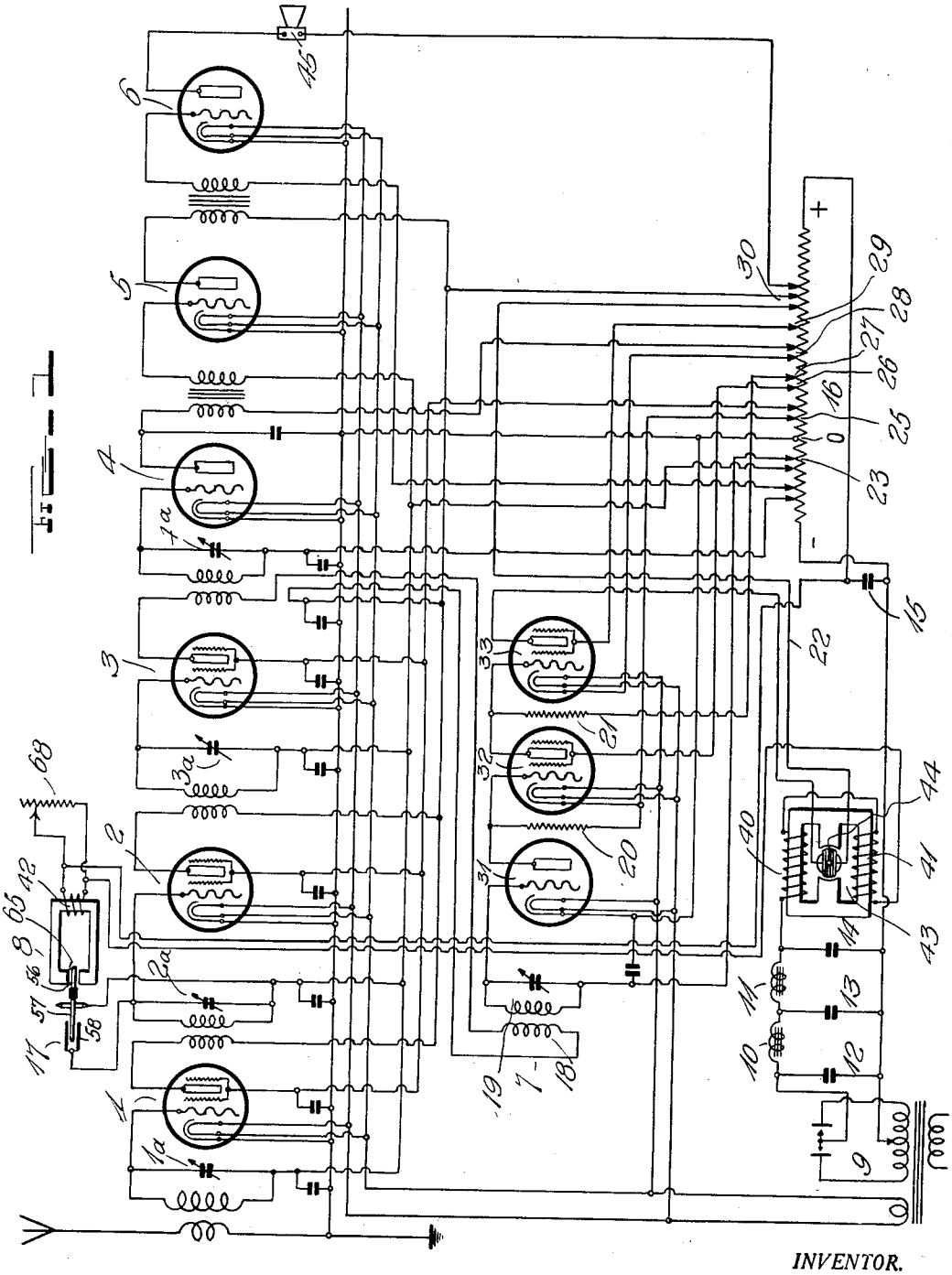
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VOLUME CONTROL SYSTEM

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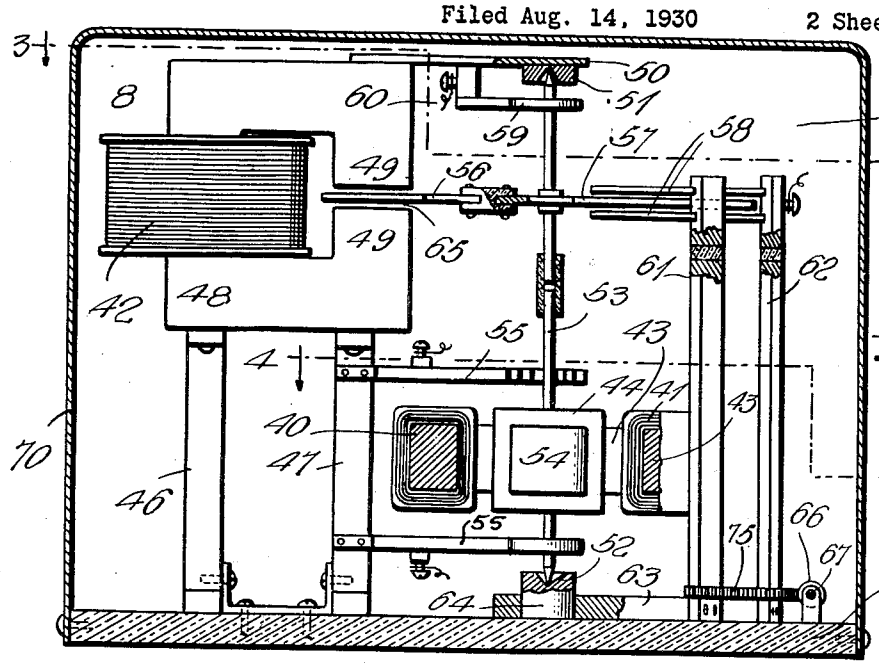


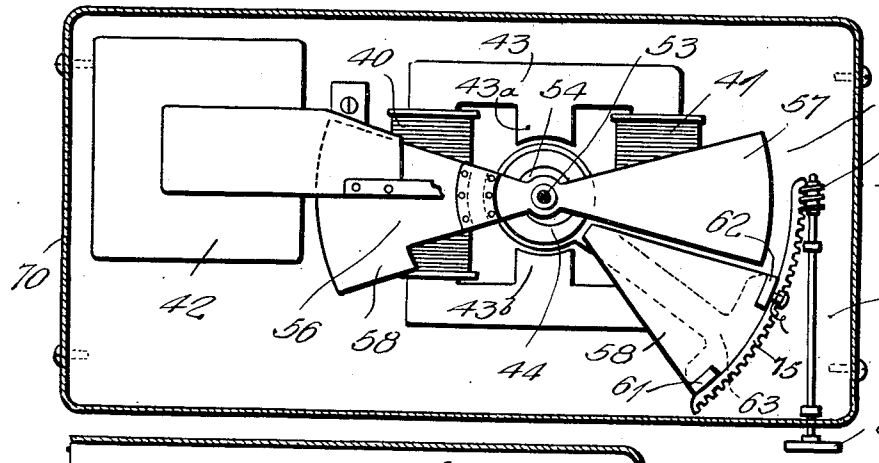
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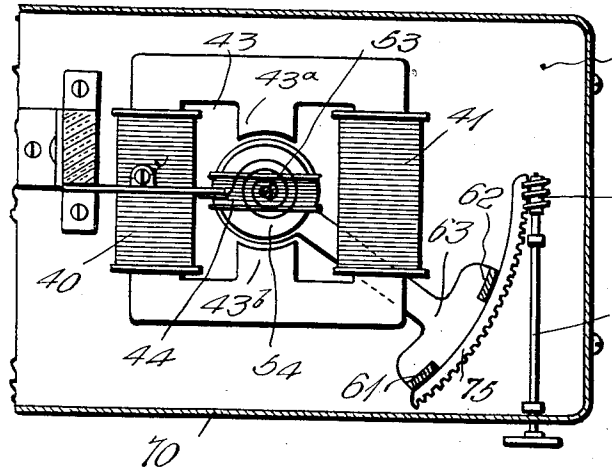
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VOLUME CONTROL SYSTEM

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UNITED STATES PATENT OFFICE

1,950,144

VOLUME CONTROL SYSTEM

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Application August 14, 1930, Serial No. 475,228

20 Claims. (Cl. 250—20)

My invention relates broadly to radio receiving circuits and more particularly to an automatic volume control system for radio receiving circuits.

One of the objects of my invention is to provide means for automatically detuning the circuits of a radio receiver under conditions of fading in the event that the received signaling energy tends to increase in amplitude beyond a predetermined normal value.

Another object of my invention is to provide means for automatically changing the effective value of a tuning impedance in the circuit of a radio receiver in proportion to the volume of sound reproduced by the receiving system.

Still another object of my invention is to provide a construction of electromagnetic control device adapted to be connected to standard forms of radio receiving circuits for detuning the receiving circuit under conditions of increase in volume of the reproduced sound at the receiver for maintaining a substantially uniform amount of energy in the detector circuit.

A further object of my invention is to provide an arrangement of electrodynamic control apparatus having a field winding and an armature winding with the field winding energized from the power circuits of a radio receiving system and the armature winding energized according to the amplitude of the incoming signaling energy for controlling by the electrical reaction thereof the condition of resonance of the signaling receiving circuit with respect to the incoming signaling energy for maintaining the energy input to the detector substantially constant.

A still further object of my invention is to provide a system of volume control for a radio receiver wherein the frequency adjustment of the receiving circuits is controlled according to the amplitude of the radio frequency energy at the receiver.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 diagrammatically illustrates a receiving circuit embodying the volume control system of my invention; Fig. 2 is a side elevation taken through the electrodynamic control apparatus employed in the receiving circuit in the volume control system of my invention with parts broken away and illustrated in cross-section; Fig. 3 is a view taken through the control apparatus of my invention on line 3—3 of Fig. 2 and Fig. 4 is a plan view of the control mechanism taken on line 4—4 of Fig. 2.

In the control system of my invention I provide means including an electrodynamic device adapted to selectively detune the receiving circuit under conditions where the amplitude of received energy may increase due to fading or other phenomena whereby the radio frequency energy input to the detector is maintained substantially constant. The electrodynamic device includes a field winding and an armature winding where the field winding is energized from the power circuits of the receiving system. The armature winding is energized in proportion to the incoming signaling energy. The reaction between the sets of windings is utilized to produce a turning torque by which a tuning device may be operated for detuning the receiving circuit in the event that the amplitude of the incoming signal energy tends to increase above a predetermined value. I provide automatic means for introducing sufficient inertia in the moving system of the tuning element to prevent fluctuations or swings in the resonance condition of the receiving circuit.

The details of the circuit arrangement and the electrodynamic control apparatus of my invention will be understood more fully by detailed reference to the drawings.

The receiver is diagrammatically shown including radio frequency amplifier stages 1, 2 and 3 of the shield grid, heater type cathode. A detector 4 and power amplifier 5 and 6 is provided connected to loudspeaker 45. The radio frequency amplifier stages are tuned by condensers 1*a*, 2*a* and 3*a*, and the input to the detector is tuned by condenser 4*a*. Condenser 17 is connected in shunt with tuning condenser 2*a* and serves as the volume control condenser.

Reference character 9 designates the rectifier and 10, 11, 12, 13, 14 designate the elements of the filter system. The three magnetizing windings 40, 41 and 42 of the volume control device 43 and 8 are connected in series, and with condenser 15 serve as one of the sections of the filter system. Thus two purposes are accomplished; magnetization of the iron cores of the volume control devices, 8 and 43, and filtering of the current supply. The two parts of the electrodynamic device which are shown separated in Fig. 1, are in reality parts of a single unit as can be seen in Fig. 2.

Reference character 7 designates a rectifier or detector and direct current amplifier. The pri-

mary winding 18 is connected in series with the primary of the last radio frequency transformer, and is the primary of the rectifier input transformer which has secondary winding 19. Reference character 31 designates a rectifier, while 32 and 33 indicate direct current amplifier stages. Two amplifiers are shown, because the plate current in the first amplifier decreases when plate current in tube 31 increases. The volume control device may be operated with one amplifier, by arranging the circuit so that with maximum current in coil 44 maximum sensitivity of the receiving set would be obtained, but it is considered best to have the set in maximum sensitivity condition with least current in coil 44. When plate current increases in tube 31, the plate current in tube 33 also increases. By adjusting contacts 28 and 27 along potentiometer 16 the grid of tube 33 can be biased so there is no current in the plate when there is no energy in input circuit 19, or the electrodynamic device can be so adjusted as to be in position for maximum sensitivity with a small current in the plate of tube 33.

One method of determining the point at which the volume control begins to be effective is to bias the grid of tube 31, by adjusting connection 23 to place a high negative bias on the grid of tube 31 so that no pulses of plate current flow in this tube until the desired volume of signal has been reached in the receiver. Thus there will be little drain of energy from the receiver when weak signals are being received.

Reference character 22 designates the lines leading to coil 44 of the volume control device from the output circuit of the direct current amplifier 32 and 33.

In Fig. 2 I have shown the volume control device 8 as comprising base 71, supporting members 46 and 47, and iron core 48. The iron core 48 has opposed poles 49 separated by a gap as shown, the core 48 serves to support the laterally projecting member 50 serving as a bearing for shaft 53. 51 and 52 represent jewel or other low friction bearings, in which shaft 53 is free to rotate. 43 represents an electromagnetic system which is energized by means of the direct current flowing in windings 40 and 41. These are so connected that their flux is added through the angularly adjustable armature 44 in the center of the electromagnetic system 43. 44 is a coil of many turns of fine wire, and is carried rigidly by shaft 53. The coil is located between the center poles 43*a* and 43*b* of the electromagnetic system. A magnetic core 54 is provided for the armature coil 44. The purpose of this is to keep the reluctance of the magnetic path as low as possible, and the space between core 54 and pole pieces 43*a* and 43*b* and the space occupied by the coil 44 should be kept small for the same reason. This is the construction employed in microammeters, so as to reduce the weight of the moving parts.

The coil 44 may be wound directly on magnetic member 54 in slots provided to receive the turns of the winding so that it is possible to have a very small air gap, and therefore low magnetic reluctance. Coil 44 is, of course, to be so placed that when direct current flows through it, there will be a maximum of torque between it and the pole pieces 43*a* and 43*b*. The current in the coil is the current derived from the radio receiving system, and which is to be used in controlling the volume.

Coil springs 55 are connected to shaft 53, and to member 47 through intermediate members carrying terminals. Though not shown in detail, the connection between the springs 55 and member 47 is adjustable, so that when current ceases to flow in coil 44 rotating plates 56 and 57 will return to the desired position. Member 47 is made of insulating material, and wires 22 in Fig. 1 are fastened to the terminals shown. This corresponds to the zero adjustment of an ammeter.

Shaft 53 is to be secured to coil 44 by any suitable method. The supports for electromagnetic system 43 are not shown, but any suitable brackets may be used.

Plate or vane 57 is the movable plate of the condenser, and plates 58 are the fixed plates. Electrical connection to the movable plate 57 is made through spring 59 and binding post 60 which should be the low potential side. There may be several plates in this condenser.

There are two methods of controlling the point at which the volume control begins to be effective. One method is to bias the rectifier tube 31 which supplies current for coil 44 so that no current is passed until the energy in the circuit reaches a desired value. The other method is to allow current to flow in coil 44 all the time, but to construct the control device so that plate 57 does not enter between plates 58 until a certain amount of rotation has taken place. Therefore plates 58 are angularly adjustable so that this time of entering can be chosen to occur when the desired volume of signal has been reached. Plates 58 are supported by members 61 and 62, which are carried by base member 63, which is held in place by and rotates around cylindrical projection 64 which in turn supports jeweled bearings 52. The arcuate shaped gear or segment 75 is carried by member 63 and is angularly adjusted by gear member 66 which meshes therewith. The shaft 67 is adjustable to change the position of gear 66 and segment 75.

Plate 56 and iron core 48 of volume control device 8 constitute a magnetic clamping device. Winding 42 magnetizes core 48. There is a narrow opening or gap 65 between pole pieces 49 between which plate 57 moves. Plate 56 is of metal, and therefore any motion of it in the strong magnetic field creates eddy currents, the effect of which is to exert a retarding action on any movement of plate 56. This is to prevent oscillation of the rotating parts, so as to prevent the control condenser from following minor variations in signal amplitude. Extension 53 on plate 56 is for the purpose of keeping a portion of plate 56 between poles 49 even though enough rotation has ocurred to bring plate 57 entirely out from between plates 58.

In Fig. 1 I have shown a method for using the plate current supply of the receiving system as the source of direct current for the energization of windings 40, 41 and 42.

The windings 40, 41 and 42 with their associated magnetic core members serve as reactances to more thoroughly filter the rectified alternating current supplied to the potentiometer or power distribution circuit for energizing the several circuits of the receiver.

In order to more accurately govern the damping properties of the electromagnetic system 8, I provide an adjustable resistance 68 in shunt with the winding 42 on the electromagnetic core member 8.

The amount of detuning effected by the operation of condenser 17 in shunt with the condenser 2*a* is adjusted to meet predetermined conditions. A detuning device may be employed in connection with each tuning stage of amplification rep-

resented in 1*a*, 2*a*, 3*a* and 4*a*. For purposes of explaining the principles of my invention I have illustrated a single detuning device but it will be understood that a multiple number of such devices may be employed or condenser 17 could be placed in the antenna circuit, and used as an antenna tuning condenser. The electrodynamic device is properly shielded from the associated parts of the radio frequency amplification system as I have illustrated by the enclosed casing 70. The leads between the detuning conductor 17 and the main tuning conductors of the receiving ciruit are maintained as short as practicable.

While I have described my invention in one of its preferred embodiments I desire that it be understood that modifications may be made and that no limitation upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A volume control system for radio receiving circuits comprising a tuned radio-frequency amplifier having a plurality of successively coupled stages, a detector connected thereto, an audio-frequency amplifier connected therewith, a sound reproducer connected with the output circuit of said radio-frequency amplifier, an electrodynamic device responsive to amplitude variations in the signal energy impressed upon said detector, and detuning means connected intermediate certain of the stages of said tuned radio-frequency amplifier for controlling the operation thereof, said detuning means being actuated by said electrodynamic device.

2. A volume control system for radio receiving circuits comprising a tuned radio-frequency amplifier having a plurality of successively coupled stages, a detector connected thereto, an audio-frequency amplifier connected therewith, a sound reproducer connected with the output circuit of said radio-frequency amplifier, an electromagnetic device responsive to amplitude variations in the signal energy impressed upon said detector, and means actuated by said electrodynamic device for modifying the character of operation of said radio frequency amplifier, said means being connected intermediate certain of said coupled stages.

3. A volume control system for radio receiving circuits comprising a tuned radio-frequency amplification circuit having a plurality of successively coupled stages, a detector connected thereto, an audio-frequency amplifier connected therewith, a sound reproducer connected with the output circuit of said audio-frequency amplifier, power means for energizing said circuits, an electrodynamic device energized from said power means and actuated in accordance with amplitude variations of the signal energy impressed on said detector and a variable capacity device adjustable under control of said electrodynamic device, said capacity being connected intermediate certain of said successively coupled stages of said radio-frequency amplifier and said capacity being adapted to modify the character of operation of said radio-frequency amplifier whereby the audio-frequency output is maintained substantially constant.

4. A signal receiving system including a radio-frequency amplifier, a detector connected therewith, an audio-frequency amplifier connected to said detector, a rectifier and amplifier circuit connected intermediate the output of said radio-frequency amplifier and the input of said detector, an electrodynamic device responsive to variations in the amount of energy transferred from said radio-frequency amplifier to said detector and means connected with said radio-frequency amplifier and operated by said electrodynamic device for modifying the tuning of said radio-frequency amplifier so as to maintain substantially constant the amplitude of output energy delivered by said audio-frequency amplifier.

5. In a signal receiving system, a radio frequency amplifier, a detector connected therewith, an auxiliary circuit including an independent rectifier and direct current amplifier connected intermediate said radio frequency amplifier and first mentioned detector, electrodynamic means having an angularly movable element, a pair of windings associated therewith, one of said windings being connected with the output circuit of said independent rectifier and amplifier power means for energizing said amplifiers, detector and rectifier, the other of said windings being connected with said power means whereby angular movement is imparted to said movable element under conditions of change in amplitude of signal current and a tuning device connected with said radio frequency amplifier and operated by said movable element and adapted to control the tuning of said radio frequency amplifier.

6. In a signal receiving system, a radio frequency amplifier, a detector connected therewith, an audio frequency amplifier connected with said detector, a sound reproducer connected to said audio frequency amplifier, an independent rectifier connected with the output circuit of said radio frequency amplifier, a direct current amplifier connected with said independent rectifier, and an electrodynamic device connected with the output circuit of said direct current amplifier and a tuning device connected with said radio frequency amplifier and shiftable by said electrodynamic device for selectively controlling the tuning of said radio frequency amplifier according to the amplitude of the signal energy transferred from said radio frequency amplifier to said detector.

7. In a signal receiving circuit a radio frequency amplifier, a detector connected therewith, an audio frequency amplifier connected to said detector, a sound reproducer connected with said audio frequency amplifier, a monitoring circuit connected with the output of said radio frequency amplifier, a variable tuning element and electrodynamic actuating device for said variable tuning element connected into said monitoring circuit, said variable tuning element being adapted for modifying the tuning of said radio frequency amplifier according to the amplitude of the signaling energy transferred from said radio frequency amplifier to said monitoring circuit.

8. In a signal receiving circuit, a radio frequency amplifier, a detector connected with said radio frequency amplifier, an audio frequency amplifier connected with said detector, a sound reproducer connected to said audio frequency amplifier, power supply means for the circuits of said radio frequency amplifier, detector and audio frequency amplifier, an electrodynamic device having one portion thereof energized from said power supply means and another portion thereof energized by signaling energy transferred from the output of said radio frequency amplifier, and means controlled by said electrodynamic device for modifying the tuning of said radio frequency amplifier according to the amplitude of the sig-

naling energy transferred from said radio frequency amplifier to said detector.

9. In a signal receiving circuit, a radio frequency amplifier, a detector connected with said radio frequency amplifier, an audio frequency amplifier connected with said detector, a sound reproducer connected to said audio frequency amplifier, power supply means for the circuits of said radio frequency amplifier, detector and audio frequency amplifier, an electrodynamic device having a field winding and a rotatable armature winding, said field winding being connected with said power supply means, and said armature winding being connected to receive energy variable in amplitude according to a variation in signal energy transferred from said radio frequency amplifier to said detector, and means controlled by said electrodynamic device for modifying the tuning of said radio frequency amplifier according to the amplitude of the signaling energy impressed upon said detector from said radio frequency amplifier.

10. In a signal receiving circuit, a radio frequency amplifier, a detector connected with said radio frequency amplifier, an audio frequency amplifier connected with said detector, a sound reproducer connected to said audio frequency amplifier, power supply means for the circuits of said radio frequency amplifier, detector, and audio frequency amplifier, an electrodynamic device including a field winding disposed in circuit with said power supply means, an armature winding energized by variable current corresponding to the variations in amplitude of the signal energy in the output circuit of said radio frequency amplifier, and tuning means connected in circuit with said radio frequency amplifier and mechanically actuated by said electrodynamic device for controlling the resonant frequency of said radio frequency amplifier according to the changes in amplitude of the signal energy impressed upon said detector.

11. In a signal receiving circuit, a radio frequency amplifier, a detector connected with said radio frequency amplifier, an audio frequency amplifier connected with said detector, a sound reproducer connected to said audio frequency amplifier, power supply means for the circuits of said radio frequency amplifier, detector, and audio frequency amplifier, an electrodynamic device including a field winding disposed in circuit with said power supply means, an angularly movable armature winding adapted to receive variable current corresponding to the variable current in the output circuit of said radio frequency amplifier, a tuning device driven by said electrodynamic device, connections between said tuning device and said radio frequency amplifier, and damping means energized from said power supply means for regulating the operation of said tuning device whereby changes in amplitude of signal energy impressed upon said detector effect corresponding changes in the operation of said tuning device for effecting a detuning of said radio frequency amplifier when the signal energy impressed upon said detector exceeds a predetermined value.

12. In an automatic tuning device for a signal receiving network, a tuned circuit, an auxiliary variable condenser and a detector connected therewith, said auxiliary condenser being adapted to effect variations in amplitude of the signaling energy impressed upon said detector and means including a monitoring circuit in which is an actuating device for effecting movement of said auxiliary variable condenser in response to said energy variations whereby the output from said receiving network is maintained substantially constant.

13. In an automatic tuning device for a signal receiving network a variable condenser, means including connections between said variable condenser and said signal receiving network for modifying the resonance thereof, a detector connected with said network, means for effecting a movement of said variable condenser in accordance with the amplitude of the signaling energy impressed upon said detector and means for damping the movement of said variable condenser.

14. In an automatic tuning device for signal receiving circuits, a tuned circuit, a variable condenser and a detector connected with said tuned circuit, means for effecting movement of said variable condenser in accordance with the amplitude of the signaling energy impressed upon said detector whereby the output energy from said signal receiving circuits is maintained substantially constant, and means for electrically damping the movement of said variable condenser.

15. In a signal receiving system, a tuned circuit, an auxiliary tuning device connected with said tuned circuit, a detector connected with said tuned circuit, and means for controlling the operation of said auxiliary tuning device comprising an electrodynamic actuator said actuator including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source whereby said actuator responds to changes in amplitude of the signaling energy impressed upon said detector for effecting angular displacement of said auxiliary tuning device for modifying the tuning of said tuned circuit according to the amplitude of the signaling energy impressed upon said detector.

16. Automatic detuning means for signal receiving circuits comprising a variable impedance device, a tuned circuit, connections between said tuned circuit and said variable impedance device, a detector connected with said tuned circuit, and electrodynamic means mechanically connected to drive said variable impedance device, said electrodynamic device including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source whereby said device responds under conditions of variations in the amplitude of the signaling energy impressed upon said detector for correspondingly adjusting the response frequency of said tuned circuit.

17. Automatic detuning means for signal receiving circuits including a tuned circuit, a detector connected with said tuned circuit, an electrodynamic device controllable by variations in amplitude of the signaling energy impressed upon said detector, said electrodynamic device including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source, a variable impedance connected with said tuned circuit and adjustable in accordance with the operation of said electrodynamic device, and means electrically associated with said variable impedance device for damping the operation of said device while said device is actuated by said electrodynamic device under control of variations in amplitude of the signaling energy impressed upon said detector.

18. Automatic detuning means for radio receiving circuits including a tuned circuit, a detector connected therewith, an electrodynamic device angularly movable in accordance with changes in amplitude of incoming signaling energy, said electrodynamic device including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source, an angularly movable member mechanically connected with said electrodynamic device, said member having a plate at one side thereon forming a capacity area adapted to interleave with plates forming an opposite capacity area, connections between said plates and said tuned circuit, an auxiliary plate extending diametrically opposite said first mentioned plate, and means for electrically damping the movement of said auxiliary plate, said electrodynamic device operating to shift said first mentioned plate with respect to the associated plates according to the amplitude of the signal energy impressed upon said detector.

19. Automatic detuning means for signal receiving circuits including a tuned circuit, a detector connected therewith, a variable impedance comprising an angularly movable plate member and a stationary plate member with which said angularly movable plate member is adapted to be variably interleaved, connections between said plate members and said tuned circuit, an electrodynamic device adapted to drive said angularly movable plate member, said electrodynamic device including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source whereby said device operates in accordance with the amplitude of signaling energy impressed upon said detector, and means projecting from said angularly movable plate for damping the movement of said angularly movable plate, whereby changes in amplitude of signaling energy impressed upon said detector effect corresponding changes in the effective value of said impedance device.

20. Automatic detuning means for signal receiving circuits including a tuned circuit, a detector connected therewith, a variable capacity device electrically connected with said tuned circuit, said capacity being constituted by a stator plate and a rotor plate, connections between said stator and rotor plates with said tuned circuit, an electrodynamic device actuated by variations in amplitude of the signal energy impressed upon said detector for controlling the relative position of said stator and rotor plates including a rotatable member carrying a winding energized by signal energy delivered by said detector and a stationary winding energized from a local power source, and means extending from said rotor plate for electrically damping the movement thereof, whereby changes in amplitude of signal energy impressed upon said detector are accompanied by corresponding changes in the effective capacity of said variable capacity device.

ERNEST R. HENTSCHEL.