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MUTING CONTROL

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Fig. 1.

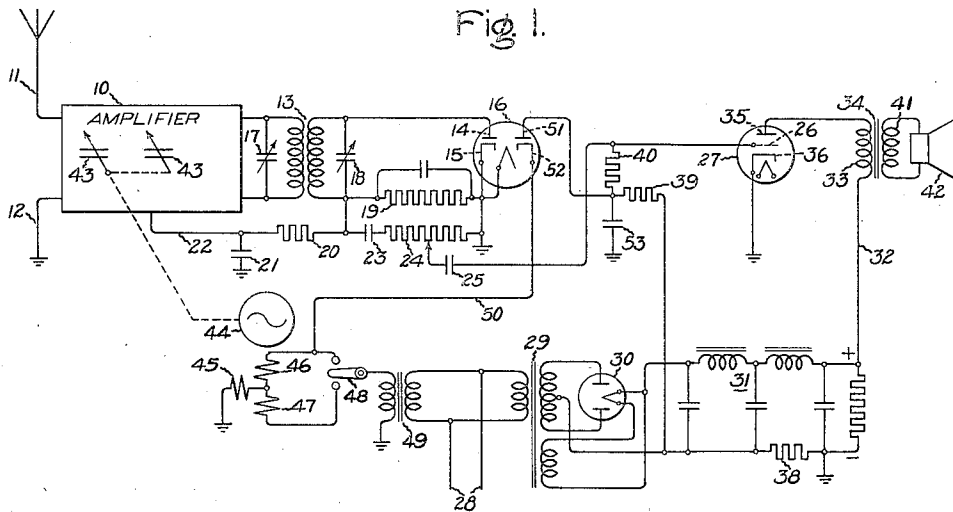
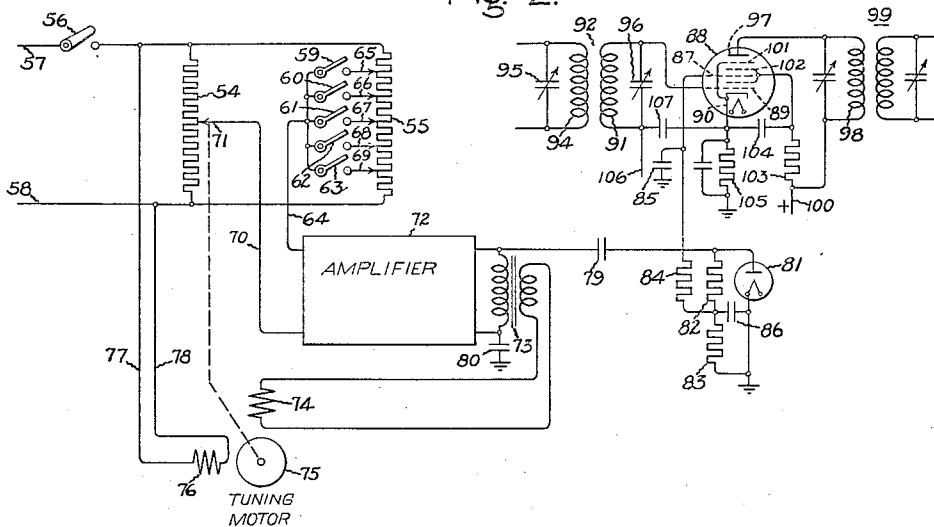


Fig. 2.



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MUTING CONTROL

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13 Claims. (Cl. 250—20)

My invention relates to an improved amplification control for a thermionic signal amplifier and more particularly to an improved silent tuning control for a radio receiving apparatus.

While tuning a radio receiver from one station to another, it is desirable that the output of the receiver shall be muted or silenced in order that intra-station noises of a disturbing and undesirable nature may not be audible. Previous attempts have been made to accomplish this result by manually-operated switching arrangements, or by electronic noise-suppressor arrangements which operate to silence the receiver output whenever a received signal carrier decreases in strength below a predetermined minimum value. Each of these methods for silencing the receiver have their serious limitations and defects which result in an operation that is not entirely satisfactory. Predominant among the defects of these prior arrangements is their inability rapidly and quietly to silence a receiver output in an automatic and reliable manner during a tuning or other adjusting operation. The very rapid silencing of receiver output in a quiet and efficient manner is especially necessary where a tuning operation, or similar adjusting operation of a circuit element is effected by an electric motor whose operation, beginning at the instant of energization, introduces into the receiver output a great multitude of loud and disturbing noises.

It is, therefore, an object of my invention to provide a muting or silencing control which overcomes the defects inherent in prior arrangements and one which has substantially an instantaneous control over the receiver output yet one which is quiet, reliable, and entirely automatic in its operation.

A further object of my invention is to provide a muting control which controls electronically the output of a signal amplifier and which therefore has an almost instantaneous muting characteristic though allowing for a desirable predetermined time delay between the deenergization of the muting control circuit and the reenergization of the signal amplifier.

A further object of my invention is to provide an automatic silent tuning control energized at all times with the tuning motor and my invention contemplates that the muting control potential may be obtained directly from the potential drop impressed across or induced in a tuning motor winding.

Another object of my invention is to provide a muting circuit in which the elements of the muting arrangement operate in the dual role of

muting elements during periods when the receiver output is muted and as filtering elements, to filter alternating current variations from the biasing source for an electron discharge device, during the remaining time when the receiver output is not muted.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 illustrates an embodiment of my invention in which a muting control potential is obtained directly from a tuning motor, and Fig. 2 illustrates a modification thereof and shows an arrangement wherein a muting control potential is obtained from the unbalance of a normally balanced resistive bridge.

Referring to Fig. 1 of the drawing, I have illustrated my invention as embodied in a radio receiver provided with a radio frequency amplifier, conventionally represented by the rectangle 10, which may comprise one or more stages of amplification, connected to receive energy from an antenna ground system 11, 12 and arranged to supply amplified signal energy through a transformer 13 to the diode elements 14, 15 of the electron discharge device 16. The radio frequency amplifier 10 preferably consists of one or more stages of radio frequency amplification, of a converter to change the signal carrier oscillations to oscillations of intermediate frequency, and of one or more stages of amplification for the oscillations of intermediate frequency. In the preferred embodiment, the primary and secondary windings of the transformer 13 are tuned by the respective condensers 17, 18 to the intermediate frequency.

A uni-directional potential appears across the resistor 19 as a result of the rectification of the signal oscillations by the diode elements 14, 15 and this potential is supplied through a filter comprised by resistor 20 and condenser 21 to an automatic volume control circuit 22 of the receiver which operates to control the amplification of the several amplifier stages 10 in a manner well known in the art. The uni-directional potential appearing across the resistor 19 is modulated in accordance with the received signals. This potential in addition to being supplied to the automatic volume control circuit 22 is also coupled through a condenser 23 to a voltage divider 24 and a portion thereof is coupled

through a condenser 25 to the control grid 26 of an electron discharge signal amplifier 27.

An anode potential for the electron discharge signal amplifier 27 is obtained from a power source 28 through a power transformer 29, a full wave rectifier 30, and a filter 31. This anode potential is supplied through the conductor 32 and the primary 33 of an output transformer 34 to the anode 35 of the electron discharge signal amplifier 27. The cathode 36 of the amplifier 27 is connected through ground to the negative terminal of the anode supply source. A normal operating bias for the grid 26 of the electron discharge signal amplifier 27 is obtained by inserting a resistance 38 in the negative lead of the anode supply source and by supplying the potential drop appearing across this resistor through the resistors 39 and 40 to the grid. The output transformer 34 is provided with a secondary 41 which is preferably connected to the input of an additional stage of audio frequency amplification but is here shown for purposes of simplicity as connected directly to a loud speaker 42 or other translating device.

The tunable elements 43 of the radio frequency amplifier 10 are mechanically connected through a suitable reduction drive mechanism to the armature 44 of a tuning motor which has, in addition to the armature 44, a main field winding 45 and direction controlling field windings 46, 47. The direction of rotation of the motor armature 44, and thereby the direction of adjustment of the adjustable elements 43 to effect a tuning operation, is determined by a switch, which, on the drawing is represented as a single-pole double-throw switch 48. This switch controls the energization of the motor from the supply source 28 through a power transformer 49. The switch 48 is moved either to the upper or lower contact thereby to energize the motor winding 45. The motor armature 44 rotates in a direction depending upon which of the field windings 46, 47 was energized and drives the tunable elements 43 of the radio receiver to a position in which the receiver is accurately tuned to the frequency of a desired signal oscillation. Thereupon the motor is deenergized by manually moving the switch 48 to a neutral position intermediate the upper and lower switch contacts as shown in the drawing. It will, of course, be evident that the switch 48 may be replaced by or connected in parallel with other control circuits as of the manually-operated push-button type which suitably energize and control the direction of operation of the tuning motor. Representative of control circuits of the latter type is that shown in the United States Letters Patent No. 1,934,493 to Geyh.

Both the increase in sensitivity of the receiver under normal action of the automatic volume control and the electrical currents flowing in the tuning motor and associated circuits contribute to cause the receiver output to become very noisy during the operation of tuning from one signal frequency to another. Such noise is of a highly annoying and disturbing nature and is quite objectionable to a person operating the receiver. To overcome this objectionable condition of operation, a silent tuning control circuit is provided. This circuit operates in an automatic manner to silence the receiver during the time when the motor armature 44 is rotating in effecting a desired adjustment of the tunable elements 43.

A muting control potential, provided by the voltage drop across the motor field winding 45, is supplied through a conductor 50 to a pair of diode elements 51, 52 contained in the electron discharge device 16 and, after rectification, is utilized to charge a condenser 53 connected between ground and the junction of the resistors 39, 40. It will be evident that as soon as the switch 48 is moved to energize either of the field windings 46 or 47, the potential drop appearing across the motor winding 45 is supplied through the conductor 50 to the diode elements 51, 52 and the condenser 53 is almost instantly charged to a direct current potential substantially equal to the maximum instantaneous potential appearing across the motor winding 45. The potential across the condenser 53 is applied through the resistor 40 to the grid 26 of the amplifier 27 and biases the grid 26 beyond cut-off to silence the output of the receiver by making the signal amplifier 27 unresponsive to signal impulses impressed on the grid 26. Upon opening the switch 48, the potential drop across the motor winding 45 disappears and the condenser 53 thereupon discharges through a circuit comprising the resistors 38 and 39 in series, the uni-directional conductivity of the diode elements 51, 52 of the electron discharge device 16 preventing the flow of current in the circuit comprised by the diode elements 51, 52 and the motor windings 45, 46. After a time interval, determined by the value of the resistors 38, 39, the condenser 53 has discharged sufficiently for the grid 26 of the amplifier 27 once more to acquire a normal biasing potential whereupon the signal amplifier 27 operates with full output.

The time response which is characteristic of this muting control is quite important in that it is desirable that the control shall instantaneously mute the receiver when the tuning motor is energized and shall delay for an appreciable time interval the restoration of the receiver output after the tuning motor is deenergized. It will be evident that my muting control arrangement has substantially an instantaneous muting characteristic since the condenser 53 is charged directly through the anode to cathode resistance of the diode elements 51, 52. Thus the voltage across the condenser 53 is approximately:

$$e_c = E \left(1 - e^{-\frac{t_1}{RC}} \right)$$

where

E=peak A. C. voltage across the motor field winding 45

R=resistance of the anode to cathode path of the diode elements 51, 52

C=capacity of the condenser 53

If a 6H6 type of electron discharge device 16 be used, the anode to cathode resistance of the diode elements 51, 52 is about 2,500 ohms. If the condenser 53 be given a value of 0.1 mfd., the voltage across the condenser 53 will be one half of the instantaneous maximum value of that across the motor field winding 45 in the time where

$$\frac{t_1}{RC} = 0.7$$

or

$$t = 0.7 RC = 0.7 \times 2500 \times 10^{-7} \\ = 175 \text{ microseconds}$$

Now when the tuning motor is deenergized, the condenser 53 will discharge through the resistors 38, 39 in series. If the resistor 38 has the value of 10 ohms and the resistor 39 be given a value

of 500,000 ohms, the voltage across the condenser 53 will be one half its initial value when

$$\frac{t_2}{R_2 C} = 0.7$$

or

$$t_2 = 0.7 \times 500,000 \times 10^{-7} \\ = 35,000 \text{ microseconds}$$

Thus the radio receiver is silenced practically instantaneously, but there is a time delay of appreciable magnitude before the output of the receiver becomes again audible after the motor is deenergized. The time delay in returning to audibility allows the tuning motor to come to a complete stop and to thereby become perfectly quiet from the standpoint of introducing any noise into the radio receiver by its operation.

My muting circuit arrangement has an additional advantage in that the resistors 39 and 40 are connected to the left-hand end of the biasing resistor 38 and therefore serve with the condenser 53 as a ripple filter for any slight ripple which may appear in the voltage drop across the biasing resistor 38. By utilizing the resistors 39, 40 and the condenser 53 in this dual function, a material saving results in the cost of component parts of the radio receiver.

A modification of my muting control circuit is illustrated in Fig. 2. In this arrangement, a muting potential is provided by the unbalance of the resistive bridge comprised by the resistors 54 and 55 which are connected through a switch 56 across the power supply source 57, 58. A plurality of switches 59—63 are mechanically interlocked by an arrangement, not shown, which allows only one switch at a time to close and thereby establish an electrical connection between a conductor 64 and one of the movable contacts 65—69 provided on the resistor 55. A conductor 70 is connected to a movable contact 71 provided on the resistor 54. It will be evident that this arrangement of resistors and their cooperating adjustable contacts provides a resistive Wheatstone bridge which may be balanced after closure of a selected one of the switches 59—63 by suitable adjustment of the movable contact 71 along the resistor 54, the balanced condition of the bridge being indicated by an absence of potential between the conductors 64 and 70.

Any potential drop appearing across the conductors 64, 70 is amplified by a suitable amplifier, represented conventionally by the rectangle 72, and the output of the amplifier is connected through an output transformer 73 to a field winding 74 of a tuning motor. The tuning motor has an armature 75 mechanically connected to the tuning elements of the radio receiver and also mechanically connected movably to position the contact 71 along the resistor 54. The tuning motor is further provided with a winding 76 arranged in electrically spaced position with relation to the winding 74. The winding 76 is connected by conductors 77, 78 with the respective power supply lines 57, 58.

The switches 59—63 are preferably actuated by a manual push-button control, not shown, from the front of the radio receiver cabinet. Assume that the closing of a selected switch 59—63 unbalances the bridge circuit to produce a potential between the conductors 64, 70. This potential is amplified by the amplifier 72 and is supplied through the transformer 73 to the field winding 74 of the tuning motor. The armature 75 of the tuning motor moves under the combined influence of the field windings 74 and 76 to adjust

the tuning elements of the radio receiver to a position predetermined by the setting of an adjustable contactor 65—69 corresponding to the switch that was closed. In moving, the armature 75 also drives the adjustable contact 71 to a new position on the resistor 54 at which the bridge is again balanced and the potential between the contactors 64, 70 disappears. When this condition occurs, the motor field winding 74 no longer has an excitation potential impressed thereacross and the motor armature 75 comes to rest. Should the armature 75 rotate too far, it will carry the movable contact 71 beyond a position on the resistor 54 at which the bridge is balanced and an excitation potential reversed in phase is thereupon impressed across the motor field winding 74 to cause the motor armature 75 to revolve in a reverse direction.

During the time when the tuning motor is driving the tuning elements of the receiver to effect a desired adjustment, it is desirable that the output of the receiver shall be silenced. A muting potential is obtained from the output of the amplifier 72 and is supplied through the condensers 79, 80 to a diode rectifier 81 having a pair of resistors 82, 83 connected thereacross. A unidirectional potential resulting from rectification of the voltage supplied by amplifier 72 thus appears across these resistors. That portion of the drop appearing across the resistor 83 is connected through a ripple filter comprised by a resistor 84 and condensers 85 and 86 to the grid of an electron discharge device, here shown by way of illustration as the injector grid 87 of an electron discharge device 88 provided in an intermediate frequency stage of amplification.

The electron discharge device 88 has a control grid 89 and a cathode 90 which are connected to the secondary 91 of an input intermediate frequency transformer 92. The transformer 92 is provided with a primary winding 94 and a secondary winding 91 respectively tuned by the condensers 95 and 96 to the input intermediate frequency. The electron discharge device 88 is also provided with an anode 97 connected through the primary 98 of an output intermediate frequency transformer 99 to a source 100 of anode potential. The device 88 has a suppressor grid 101 connected directly to the cathode 90 and a screen grid 102 connected through a resistor 103 to the potential source 100, a condenser 104 maintaining the grid 102 at ground potential for currents of alternating frequency. A cathode biasing resistor 105 provides the control grid 89 with a normal operating bias. The low potential end of the secondary winding 91 of the transformer 92 is connected through a conductor 106 to an automatic volume control circuit, a condenser 107 being used to maintain the conductor 106 at ground potential for currents of alternating frequency.

The operation of the Fig. 2 muting control arrangement is similar to that of the Fig. 1 control circuit. Upon the appearance of a potential in the output circuit of the amplifier circuit 72 as a result of an unbalanced condition of the resistive bridge, a potential is developed across the resistors 82 and 83 and the potential drop across the resistor 83 is applied through the resistor 84 to the injector grid 87 of the discharge device 88 to drive this grid highly negative and thereby render the device 88 unresponsive to signal oscillations impressed on its control grid 89. The output of the device 88 is thereby effectively muted. As soon as the motor armature 75 has

adjusted the adjustable contact 71 to a position on the resistor 54 at which the bridge is again balanced, no potential appears in the output circuit of the amplifier 72 and the potential drop across the resistor 83 disappears to permit, thereupon, the injector grid 87 of the device 88 once more to be biased to its normal potential determined by the potential drop across the biasing resistor 105. It will be evident that the muting time response characteristic of this modified control circuit is determined by the value of the resistor 82, which is the limiting resistor in the charging circuit of the condenser 86, and that the time delay response, during which the receiver is maintained in muted condition after the tuning motor has come to rest, is determined by the time required for the condenser 86 to lose its charge, this time being determined by the value of the resistor 83 connected across the terminals of the condenser 86. If the condenser 86 is given a value of 0.1 mfd., the resistors 82 and 83 may each have a value in the order of 1 megohm.

While I have shown the muting control potential as applied to a control grid in the Fig. 1 circuit arrangement and as applied to the injector grid of an intermediate frequency amplifier in the Fig. 2 circuit arrangement, it will be evident that this control potential may be applied to other grids of electron discharge devices employed as radio or audio frequency amplifiers, detectors, or the like. Thus, while I have shown particular embodiments of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications may be made both in mechanical arrangement and the instrumentalities employed, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. The combination, in a radio receiver, of a tuning element, a motor for operating said tuning element, a condenser, means responsive to a predetermined charge in said condenser for silencing said receiver, and means responsive to the energization of said motor for charging said condenser through a unilateral conducting charging path substantially instantly to said predetermined charge, discharge of said condenser through said charging path upon deenergization of said motor being prevented by the unilateral conducting property thereof, and a resistance connected across said condenser of substantially higher value than the resistance of said charging path in the conducting direction.

2. In a silent tuning control for a radio receiver, the combination of a circuit control element, a motor for actuating said element, means for amplifying received signals, a condenser, means responsive to the charge in said condenser for reducing the amplification of said means, means responsive to the energization of said motor for charging said condenser through a unilateral conducting charging path substantially instantly to said predetermined charge, discharge of said condenser through said charging path upon deenergization of said motor being prevented by the unilateral conducting property thereof, and a resistance connected across said condenser of substantially higher value than the resistance of said charging path in the conducting direction.

3. The combination, in a radio receiver, of a

circuit control element, a motor for actuating said element, means including an electron discharge device having a grid for amplifying received signals, a condenser, means responsive to the energization of said motor for substantially instantly charging said condenser to a predetermined potential through a unilateral conducting charging path whereby discharge of said condenser through said charging path upon deenergization of said motor is prevented, means for supplying said potential as a bias to said grid to reduce the output of said amplifying means, and a discharge path for said condenser separate from said charging path and having resistance sufficiently great to delay discharge of said condenser over a period substantially greater than the time required to charge said condenser.

4. The combination, in a radio receiver having a tunable element, of an electron discharge signal amplifier having a grid and a cathode, a series connected condenser and resistor between said grid and said cathode, an electric motor for actuating said tunable element, a source of alternating current for energizing said motor, a rectifier, and means responsive to the energization of said motor for charging said condenser through said rectifier from said source in a circuit excluding said resistor, said condenser being charged with a polarity to bias said grid toward cut-off whereby the output of said signal amplifier is reduced.

5. In a tunable radio receiver, the combination of a tuning element, an electric motor for actuating said tuning element, a source of alternating current potential for energizing said motor, means for amplifying received signal oscillations, said means including an electron discharge device having a grid and a cathode, a current conductive path of high impedance connected between said grid and said cathode, a condenser included in said path, and means for silencing the output of said amplifier, said last-named means including a rectifier connected to be energized from said source of potential during operation of said motor for charging said condenser to bias said grid through said current conductive path toward cut-off.

6. The combination in a radio receiver having a tunable element, of an electron discharge signal amplifier having a grid and a cathode, an electric motor for actuating said tunable element, means including a source of alternating current for energizing said motor, a condenser and a high impedance serially connected between said grid and said cathode, a rectifier, means responsive to the energization of said motor for charging said condenser through said rectifier from said alternating current source to reduce the output of said amplifier by biasing said grid toward cut-off, a discharge path, and means responsive to the deenergization of said motor for discharging said condenser through said discharge path.

7. The combination, in a radio receiver having a tunable element, of an electron discharge signal amplifier having a grid, a source of potential having a small alternating current component and a relatively large direct current component, means for supplying said potential to said grid to provide said grid with a normal operating bias, said last-named means including resistors and a condenser arranged to filter from said potential said alternating current component, a motor for actuating said tunable element, and means responsive to the energization of said motor for charging said condenser substantially instantly to an abnormal potential whereby said grid is

quickly biased toward cut-off to reduce the output of said receiver.

8. The combination, in a radio receiver, of a tuning element, an alternating current motor for operating said tuning element, a condenser, means responsive to a predetermined charge in said condenser for silencing said receiver, and means operative upon energization of said motor for rectifying the voltage thereon to charge said condenser substantially instantly to and maintaining said condenser charged at said predetermined charge, and means operative upon deenergization of said motor for discharging said condenser over a predetermined time interval, the rate of discharge of said condenser being wholly independent of the resistance of the path through which the condenser is charged.

9. In a radio receiver, the combination of motor operated means for tuning said receiver to any one of a plurality of predetermined signal frequencies, means for amplifying received signal oscillations, a condenser, means responsive to voltage on the motor of said motor-operated means for charging said condenser substantially instantly to a predetermined potential, means for supplying said potential to said amplifier to reduce the output of said amplifier, means operative upon interruption of the voltage on said motor to discharge said condenser, and means whereby the number of said predetermined signal frequencies to which said receiver may be tuned by said motor operating means and the time required for charge or discharge of said condenser are wholly independent of each other.

10. In a radio set, motorized tuning means comprising motor means and a control circuit therefor, an automatic silencing means for said radio set during periods of operation of said motor means comprising a tube in the signal

channel of said radio set, and means for applying a voltage, which is developed across said motor means when said control circuit is closed, to said tube to bias it to cut-off.

11. The combination in a high frequency receiver, of motorized tuning means comprising motor means and a control circuit therefor, means for automatically reducing the output from said receiver during periods of operation of said motor means, said means comprising an electron discharge device in the signal channel of said receiver, and means for applying a voltage, which is developed across said motor means when said control circuit is closed, to said discharge device to reduce the signal transmitted therethrough.

12. The combination, in a high frequency receiver having tuning means, of a motor to drive said tuning means, a source of alternating voltage, means to supply alternating voltage from said source to said motor thereby to operate said tuning means, and means to reduce the output of said receiver during operation of said tuning means, said last means including an electron discharge device in the signal channel of said receiver, means to rectify said alternating voltage supplied to said motor to produce a unidirectional potential, and means responsive to said unidirectional potential to reduce the output from said discharge device.

13. A radio receiving set including an audio frequency tube having a grid, a tuning motor, and means for muting the set during operation of the tuning motor, including a winding on said tuning motor energized during the operation of the motor, means for rectifying the voltage on said winding, and means for applying the rectified voltage to said grid as a gain reducing bias.

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