

May 17, 1938.

P. F. G. HOLST

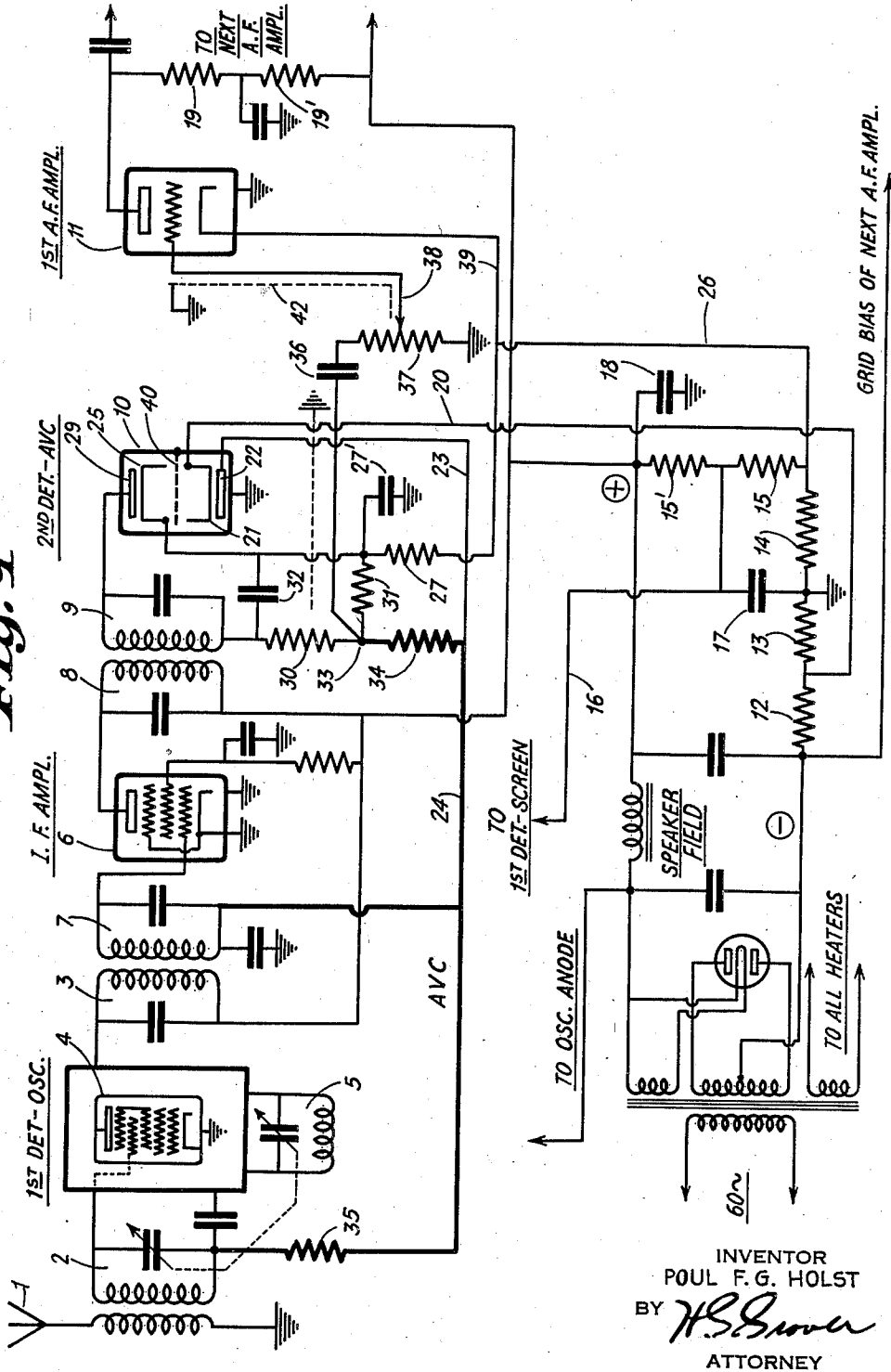
2,117,664

AUTOMATIC VOLUME CONTROL SYSTEM

Filed June 29, 1935

6 Sheets-Sheet 1

Fig. 1



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Fig. 2

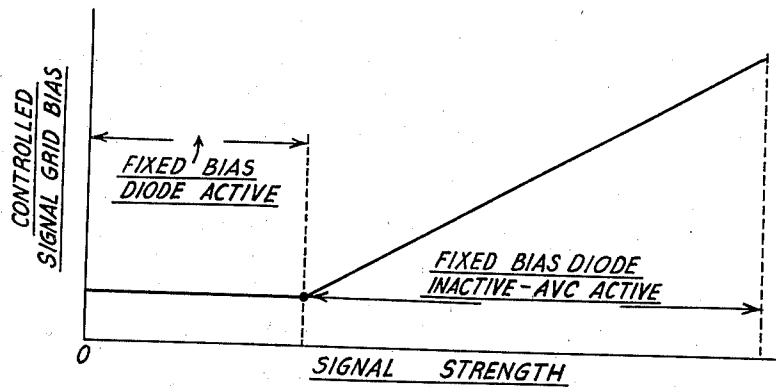
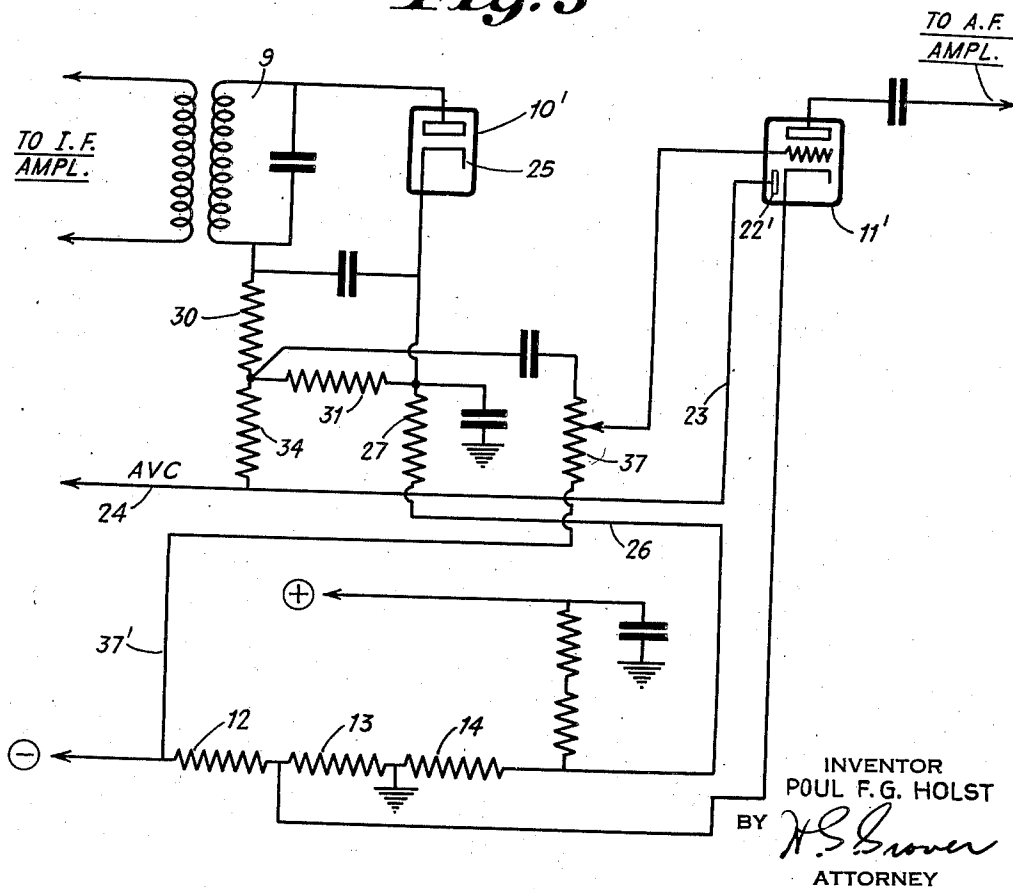


Fig. 3



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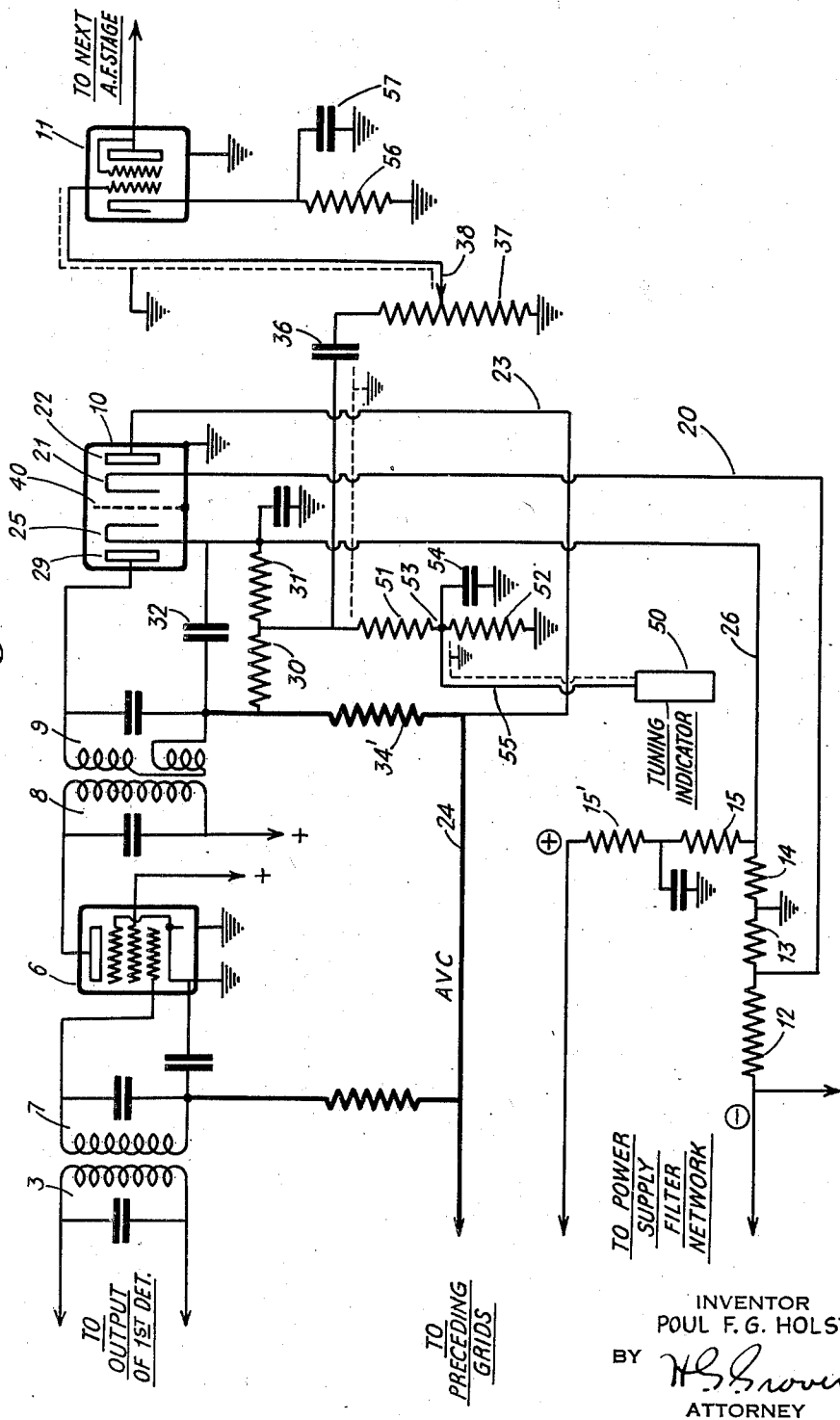
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Fig. 4



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AUTOMATIC VOLUME CONTROL SYSTEM

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Fig. 5

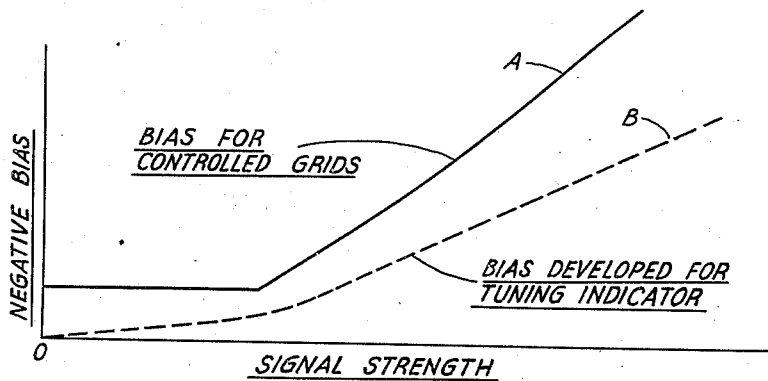


Fig. 9

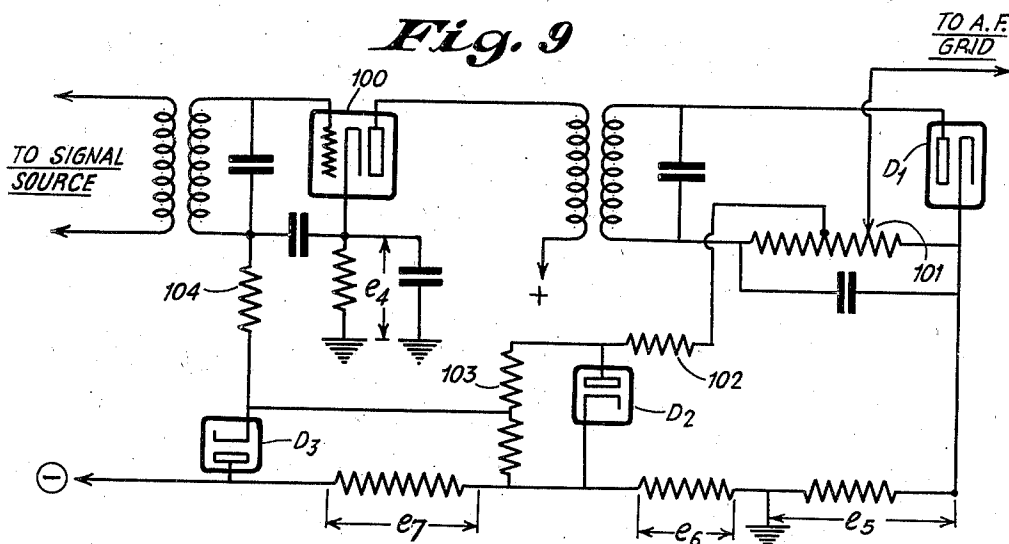
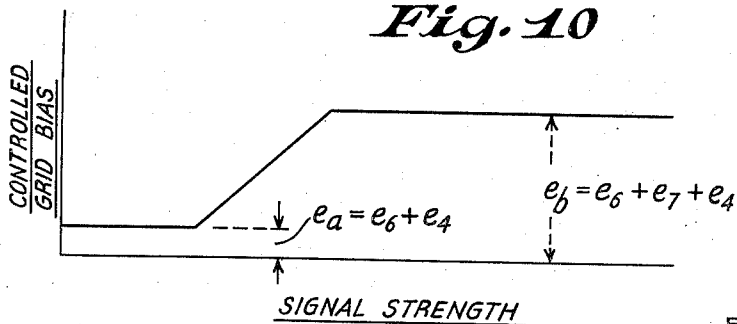


Fig. 10



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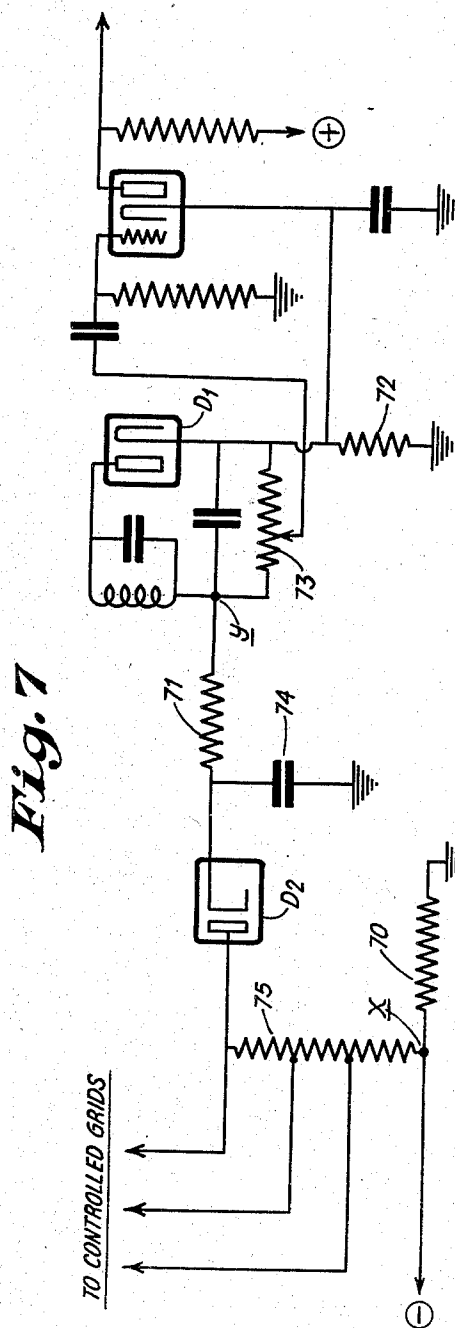
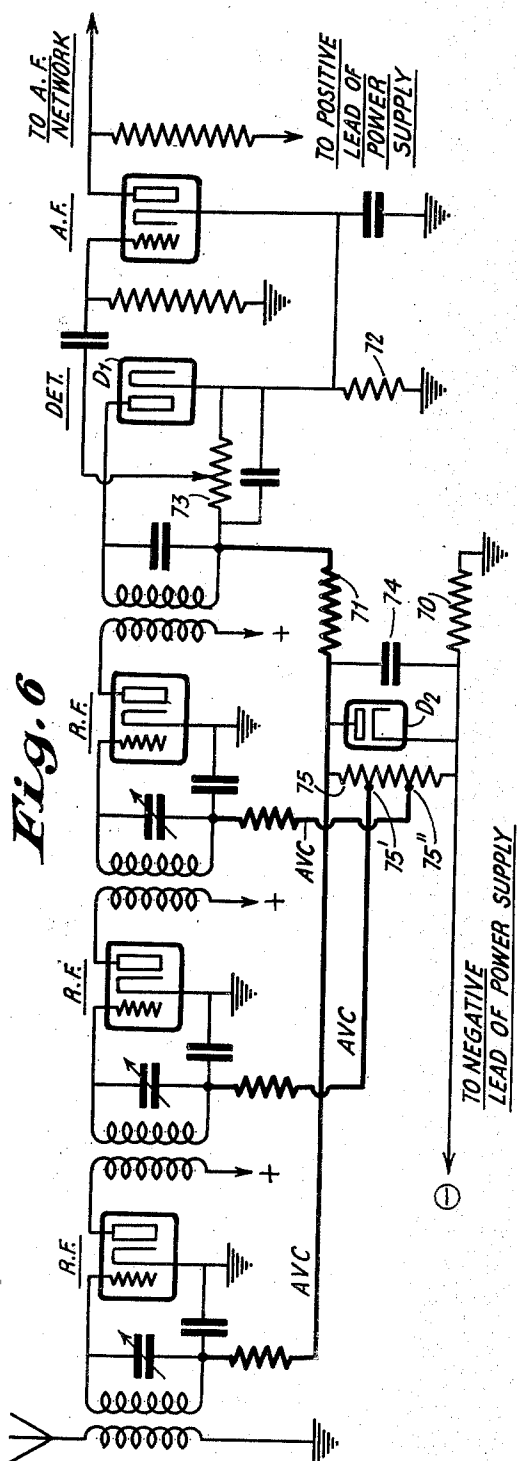
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Filed June 29, 1935

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UNITED STATES PATENT OFFICE

2,117,664

AUTOMATIC VOLUME CONTROL SYSTEM

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Delaware

Application June 29, 1935, Serial No. 29,014

16 Claims. (Cl. 250—20)

My present invention relates to control devices for high frequency signaling systems, and more particularly to improved automatic gain control mechanisms for radio signaling systems.

5 In the co-pending application of W. L. Carlson, application Serial No. 29,003, filed June 29, 1935 there has been disclosed an automatic volume control arrangement for a radio receiver wherein the anode of the gain control diode is normally maintained positive with respect to the cathodes of the tubes whose gain is under control; and during such normal condition of the receiver the initial negative bias of the control grids of the controlled amplifiers is provided by an auxiliary diode circuit. In such a prior arrangement delayed AVC action is secured; the initial grid bias of the controlled stages being replaced by the gain control bias upon the impression on the receiver of a signal having an amplitude above a predetermined intensity level.

20 One of the main objects of the present invention is to provide improved delayed AVC systems for radio receivers, which systems generally follow the mode of operation disclosed in the aforesaid Carlson application; however, the present arrangements differing from the latter prior arrangement in that the fixed grid bias diode circuit and the automatic gain control bias diode circuit are energized from a common direct current voltage source.

30 Another important object of the present invention may be said to embody the provision of a highly commercial type of automatic volume control arrangement for a radio receiver wherein the signal detector functions as the AVC tube, but has its cold gain control electrode maintained positive with respect to the cathodes of the controlled amplifier, and wherein an auxiliary bias circuit is provided to supply the normal fixed grid bias for the controlled amplifier until signals of a desired amplitude are received, and the auxiliary bias circuit embodying as a control element thereof a device of uni-directional conductivity which is under the control of the signal detector, the energization of the signal detector and the auxiliary bias circuit device being dependent upon at least two sources of direct current voltage of predetermined magnitude, as well as upon the magnitude of the incoming signal waves.

50 Another object of the invention is to provide various types of delayed automatic volume control circuits for radio receivers wherein the delay action is secured by a special diode circuit whose functioning is dependent upon a predetermined

relation between direct current voltages, and whose functioning is interrupted for replacement by an automatic biasing circuit when signal waves of a predetermined amplitude are received.

Other objects of the invention are to improve generally the simplicity and efficiency of automatic gain control networks for radio signaling systems, and more especially to provide delayed AVC arrangements for radio receivers which are not only reliable and efficient in operation, but are economically manufactured and assembled in radio receivers.

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, both as to its organization and method of operation will best be understood by reference to the following description taken in connection with the drawings wherein I have indicated several circuit organizations whereby my present invention may be carried into practical effect.

In the drawings:

Fig. 1 shows a circuit diagram of a receiver embodying one form of the present invention,

Fig. 2 graphically shows the operation of the invention,

Fig. 3 illustrates a modification of the invention,

Fig. 4 illustrates still another form of the present invention,

Fig. 5 graphically shows the operation of the modification embodied in Fig. 4,

Fig. 6 shows a further modification of this present invention,

Fig. 7 illustrates still another modification,

Fig. 8 schematically shows an additional form of the invention,

Fig. 9 shows still another embodiment,

Fig. 10 graphically shows the operation of the embodiment shown in Fig. 9.

Referring now to the accompanying drawings, wherein like reference characters in the different figures designate similar circuit elements, there is shown in Fig. 1 a superheterodyne receiver of a commercial type, and which receiver embodies a practical embodiment of the present invention which has been successfully operated. The receiver is shown as embodying customary networks preceding the second detector stage, and such networks usually comprise a conventional signal collector 1, which may be of the grounded antenna type; a loop antenna; a pick-up device of an automobile radio receiver; or even a radio

frequency distribution line as commonly employed in hotels and apartment houses.

The signal collector, regardless of its construction, is coupled to the tunable signal input circuit 2, of the converter network whose output includes the resonant circuit 3, the latter being fixedly tuned to the operating I. F. The operating I. F. may be chosen from a range of frequency values depending upon the use to which the receiver is put. If the receiver is of the multi-range type, then the operating I. F. will have a frequency value depending upon the range in which the receiver is operated. The mixer, or first detector-local oscillator, network is shown in conventionalized manner, and is to be understood as embodying a tube of the pentagrid converter type. Such tubes are well known to those skilled in the art, and the circuit networks associated with such a tube have been disclosed and claimed by J. C. Smith in application Serial No. 654,421, filed January 31, 1933. For the purposes of the present application, it is believed sufficient to point out that the numeral 4 designates a pentagrid converter tube, and that the numeral 2 denotes the tunable signal grid circuit of the tube; the numeral 5 designating the tunable local oscillator network, and the numeral 3 denoting the I. F. output circuit.

A dotted line is shown between the variable condensers of the circuits 2 and 5, and this dotted line represents the uni-control tuning mechanism of the receiver. The details of the pentagrid converter circuit are not shown, but it is to be understood that the signal grid and cathode circuits of the network are similar to those shown in connection with the succeeding I. F. amplifier tube 6. Of course, there may be utilized in place of the composite mixer stage, separate first detector and local oscillator tubes. The I. F. amplifier 6 is shown as of the pentode type, the signal input circuit 7 thereof being magnetically coupled to the circuit 3 in the customary fashion. The cathode of amplifier 6 is grounded, and the cathode of the converter tube 4 is to be understood as grounded.

The plate circuit of the amplifier 6 includes the resonant circuit 8, and the latter is magnetically coupled to a succeeding resonant circuit 9 which is disposed between the anode and cathode of the following diode functioning as the second detector-AVC control tube. Each of circuits 3, 7, 8 and 9 is to be understood as being fixedly tuned to the operating I. F. Further, if desired the couplings between these circuits may be such that optimum transmission efficiency is imparted to the networks preceding the second detector. The numeral 10 designates the double diode tube which is utilized for performing three functions. One of these functions is the demodulation function; a second function is that of controlling the gain of the preceding tubes 4 and 6; and the third function is that of providing the normal fixed grid bias for tubes 4 and 6.

The audio component of detected signal energy is impressed upon an audio amplifier 11, and the output of the latter may then be impressed upon an output tube, the final output being reproduced in any desired manner. While in the commercial embodiment of the receiving system shown in Fig. 1, the tubes employed are of the so-called metal envelope type, it is to be clearly understood that the electron discharge tubes may be of the conventional glass envelope type. It will be understood that the ground designations shown in connection with tubes 4, 6, 10 and 11 denote

the fact that the envelope of the tube is metallic and performs the dual function of housing the electrodes of each tube, and at the same time shields the electrodes from the remaining portions of the system. Since the specific construction of these metal envelope tubes is not a part of the present invention, they are schematically shown.

The various tubes of the receiving system are energized from the usual power supply network 10 which is customarily connected to the 60 cycle line. Since such power supply networks are well known at the present time, it is only believed necessary to specifically describe those portions of the supply network which are of particular utility in the functioning of the present invention. Thus, there is connected in the negative side of the power supply network, and in the output of the power supply filter, a resistor 12, a resistor 13, and a resistor 14. The junction of resistors 13 and 14 is grounded, and the positive side of resistor 14 is connected to the positive side of the power supply network through resistors connected in series. The last named pair of series resistors are denoted by the numerals 15 and 15', and the junction of these two resistors is connected by lead 16, for furnishing the positive voltage for the screen grids of the converter tube 4.

The lead 16 is by-passed to ground through a condenser 17, and the positive side of resistor 15' is by-passed to ground through condenser 18. The plate circuits of tubes 4, 6 and 11 are shown energized from the positive side of resistor 15', and the plate circuit of tube 11 is connected to the positive side of resistor 15' through resistors 19 and 19' connected in series. The normal fixed grid bias for the signal grids of tubes 4 and 6 is provided by the voltage drop across resistor 13. This is so because the cathodes of these tubes are grounded, and the negative side of resistor 13 is connected to the signal grids of tubes 4 and 6 through a path which includes the lead 20, the diode cathode 21, the diode anode 22, the lead 23, and the AVC lead 24.

It will be observed that the ground side of resistor 13 represents the fixed direct current potential of the cathodes of tubes 4 and 6. The positive side of resistor 14, that is the junction of resistors 14 and 15, is connected to the cathode 25 of the detecting diode of tube 10, through a path which includes lead 26 and resistor 27. The detection diode anode 29 is connected to the cathode 25 through the series path which includes the tuned circuit 9, the resistor 33 and resistor 34, resistors 30 and 31 being by-passed for high frequencies by condenser 32. The direct current voltage component of the rectified signal currents flowing through resistors 30 and 31 is utilized for AVC purposes by connecting the lead 24 to the junction point 33 through resistor 34. Each of the controlled signal grids is connected to the AVC lead 24 by a direct current connection, and the signal grid of converter tube 4 is connected to lead 24 through resistor 35.

The audio voltage component of the rectified signal currents is impressed upon the signal grid of audio tube 11 through a path which includes the condenser 36 having one side thereof connected to the junction point 33, and its other side connected to ground through the manual volume control resistor 37. The signal input grid of audio tube 11 is connected to any desired point along resistor 37 by the adjustable tap 38. The cathode of tube 11 is connected by lead 39, and

lead 26, to the positive side of resistor 14, and the voltage drop across resistor 14 provides the operating negative grid bias for the audio amplifier 11. In other words the resistor 14 performs the double function of maintaining the detector diode anode 29 at a normal positive potential with respect to the grounded cathodes of the controlled tubes 4 and 6, and at the same time provides the requisite operating negative grid bias for the signal grid of audio amplifier 11, it being noted that the signal grid of tube 11 is connected to the ground side of resistor 14.

By means of this construction the usual by-pass electrolytic condenser used in the grid bias network of the audio amplifier is saved, and it need not be employed. The grid bias of the audio amplifier following tube 11 is derived from across resistor 12. Returning to the double diode tube 10, it will be observed that the two diodes have their electrodes shielded from each other by means of the metal shield 40, and the shield is grounded because of its connection to the metal envelope of tube 10. From a general viewpoint the voltage drop across resistor 13 furnishes the normal operating grid bias for the signal grids of tubes 4 and 6. After a signal amplitude of a desired intensity has been attained, this normal grid bias is replaced by the automatic gain control bias which is tapped off from the junction point 33.

Considering now the specific functioning of the delayed AVC system shown in Fig. 1, attention is directed to Fig. 2 which graphically shows the manner in which the fixed bias diode is replaced by the AVC diode upon the reception of a signal of a predetermined amplitude. From Fig. 2 it will be noted that up to a predetermined amplitude of signal the diode 21—22 is active, or conductive, thereby permitting the signal grids of tubes 4 and 6 to be at substantially the direct current potential of the cathode 21. In other words, during the entire period that the diode 21—22 is active, the voltage drop across resistor 13 furnishes the sole negative bias for the signal grids of the controlled tubes; and this is so because the cathodes of these tubes are connected back to the ground point of resistor 13. Also, during this period the anode 22 is at a potential with respect to the cathode 21 which is equal to the voltage drop across resistors 13 and 14.

Furthermore, during the period when the negative grid bias for tubes 4 and 6 is derived across resistor 13, the detector diode anode 29, being connected to the positive side of resistor 14, is at a positive direct current potential with respect to the grounded cathodes of controlled tubes 4 and 6. As soon as signals are received whose amplitude exceeds the voltage developed across resistors 13 and 14, then the diode 21—22 is rendered inactive, or non-conductive. This occurs by virtue of the fact that the anode 22 is connected through lead 23 to the junction point 33. The resistor 34 functions as a filter resistor, and it is also pointed out that resistor 27 and condenser 27' function as a filter network to bypass low frequency hum. In Fig. 2 the upwardly ascending curve shows the manner in which the negative bias on the signal grids of controlled tubes 4 and 6 increases as the signal strength increases when the diode 21—22 has been rendered inactive.

At the point when the received signal amplitude exceeds the voltage across resistors 13 and 14 the negative bias applied through lead 24 is equal to the voltage developed by rectification in the circuit of diode 25—29 minus the positive voltage developed across resistor 14. It will be seen that when the diode 21—22 has been rendered inactive, then the biasing path through resistor 13 is broken. It will now be appreciated that without utilizing the usual self-bias networks in the circuits of tubes 4 and 6, a normal fixed grid bias has been provided; and additionally, the AVC action has been delayed until a signal of a predetermined amplitude is received. Upon the AVC action becoming operative, the fixed bias device becomes inoperative. It is also important to note that during normal operation of the receiver, the cold electrode of diode 29—25, the signal detector, is maintained positive with respect to the cathodes of the controlled tubes.

Merely by way of illustration, and in no way limiting, the following specific examples are given of circuit constants which may be employed in conjunction with the circuit shown in Fig. 1. Assuming that the tubes employed in the converter and I. F. amplifier stages utilize a normal fixed bias of -3 volts, and that the tube 11 is of a type which can utilize a grid bias of -1.5 volts, the following circuit constants may be utilized:

Resistor 12=175 ohms	
Resistor 13=40 ohms	
Resistor 14=130 ohms	
Resistor 30=56,000 ohms	30
Resistor 31=220,000 ohms	
Resistor 27=220,000 ohms	
Resistor 34=2.2 megohms	
Resistor 37=2 megohms	
Resistor 35=100,000 ohms	35
Condenser 32=175 mmf.	
Condenser 27'=0.1 mfd.	
Condenser 36=0.01 mfd.	

The audio transmission leads between junction point 33 and the signal grid of tube 11 are shown shielded. The dotted line designation 41, and the dotted line 42, are to be understood as comprising grounded shields for their respective leads. Again, it is emphasized that the present invention is applicable to additional circuit arrangements. For example, the fixed bias diode 21—22 need not necessarily be embodied in the same tube as the demodulator diode 29—25. This diode 21—22 may be embodied in any of the other tubes, since its function is to provide the fixed initial bias during normal reception.

In Fig. 3, there is shown a modification of the invention wherein the fixed bias diode is disposed in the tube envelope of the audio amplifier 11'. The circuit elements of the embodiment shown in Fig. 3 are substantially the same as those shown in Fig. 1; however, many of the circuit elements have been omitted which are duplicates of those shown in Fig. 1. It will be observed that the power supply network includes the ground connection at the junction of resistors 13 and 14, and that the cathode 25 of the demodulator tube 10' is connected through its lead 26 to the positive side of resistor 14. The fixed bias diode anode 22' is connected through its leads 23 and 24 to the signal grids of tubes 4 and 6. The cathode of the audio tube 11' is connected to the junction of resistors 12 and 13, instead of to the positive side of resistor 14 as in Fig. 1.

This change must be made because the signal grid of tube 11' must be maintained at a negative potential with respect to the cathode of the tube. For this reason, the signal grid of tube 11' is connected through resistor 37 and tap 37' to a point on resistor 12 which is at a negative volt-

age with respect to the point thereon to which the cathode of tube 11' is connected, and the value of this voltage is equal to that desired for normal operation of the audio tube. The tube 11' may
 5 be of the type well known to the art as a duplex-diode triode, wherein the diode anodes are strapped together to provide the single anode 22'. In this modification, then, the fixed bias diode is in another tube envelope, and yet all the func-
 10 tions noted in connection with Fig. 1 are still obtained.

The arrangement shown in Fig. 4 in general embodies the circuit elements shown in Fig. 1. Only those portions of the circuit are shown
 15 which are essential to a clear understanding of the differences in the embodiment. The delayed AVC system shown in Fig. 4 is usually employed in commercial practice in connection with a multi-range superheterodyne receiver which uses separate first detector and local oscillator tubes, and a stage of radio frequency amplification ahead of the first detector. Further, the receiver is provided with a tuning indicator 50 of any conventional and well known type. The purpose of the
 20 tuning indicator is to facilitate the tuning manipulation, the latter being rendered somewhat more difficult by the inclusion of the AVC system.

To provide the actuating negative bias for the tuning indicator device 50, the junction of the detector diode load resistors 30 and 31 is connected to ground through a path which includes resistors 51 and 52, the junction 53 of the series resistors being by-passed to ground through condenser 54. The negative bias for the tuning indicator 50 is derived from the junction point 53, and it will be observed that the lead 55 over which this partial bias is transmitted, is shielded. The AVC bias is transmitted through the lead 24, the latter being connected in this case to the anode
 40 side of resistor 30 through a resistor 34', and the audio component of rectified signal currents is transmitted to the audio tube 11 by the audio connection to the junction point of resistors 30 and 31, the latter connection being similar to that
 45 shown in Fig. 1.

Otherwise the circuit arrangement shown in Fig. 4 is similar to that shown in Fig. 1. The anode 22 of the fixed bias diode is connected through lead 23 to the AVC lead 24, and the
 50 cathode 21 is connected through lead 20 to the negative side of resistor 13. The demodulator diode cathode 25 is connected through lead 26 to the positive side of resistor 14. Of course, by proper proportioning of the resistors 51 and 52, any partial negative bias, or any fraction desired, may be supplied to the tuning indicator 50. The input circuit 9 of the demodulator diode has its coil arranged to buck out hum frequencies; the circuit constants may be changed to suit the purposes of the present receiver. For example, resistors 13 and 14 may now have values of 28 and 50 ohms respectively; resistor 34' may have a value of 2.2 megohms; resistors 51 and 52 may have values of 2.2 megohms and 880,000 ohms, respectively.
 65

The audio tube 11 is here shown as employing a self-bias resistor 56, by-passed in the usual manner by condenser 57. This self-bias network is employed where the tube 11 is of a type requiring a higher negative bias than that developed across resistor 14. For example, a tube of the type shown at 11 may utilize a bias of -9 volts, and therefore, could not utilize the lesser negative voltage developed across resistor 14.
 70 The manual volume control connection between

the diode demodulator and audio tube 11 has been simply shown, but it may be of the tone compensated type if desired. It is to be noted that unlike the arrangement shown in Fig. 1, there is no need to utilize in this modification the filter network 27-27'.
 5

In Fig. 5 there is shown the operation of the system disclosed in Fig. 4; the two curves shown in this figure illustrating the difference in variation between the negative bias supplied to the tuning indicator, and that supplied to the controlled tubes. The curve A is the same as the curves shown in Fig. 2. The curve B shows the variation in negative bias at junction point 53 in Fig. 4. It will be seen that the negative bias for the tuning indicator develops as soon as signal currents are rectified across the demodulator load resistors. This is explained by the fact that the bias transmitted to the tuning indicator is not affected by the fixed bias diode network.
 10 15 20

It is also to be noted in these different circuit arrangements embodying the present invention that a certain degree of delayed detection is secured by virtue of the voltage drop across resistor 31. When it is realized that this resistor is disposed in the path of the fixed bias diode, it will be seen that the diode demodulator 29-25 will not rectify until received signals have attained at least that amplitude which will exceed the voltage developed across resistor 31. This is best seen by reference to Fig. 1 wherein it will be seen that the resistor 31 is in series between the electrodes 21 and 22 with the voltage drops across resistors 13 and 14. Such delayed detection reduces the noise reproduction to a great extent.
 25 30 35

In each of Figs. 1, 3 and 4 the grids of the controlled tubes are shown connected to the same control bias point of the AVC network. Such a manner of connecting the circuits is not essential since the control bias may be applied to the successive controlled tubes in gradually diminishing intensity. In Fig. 6 such a modification is shown.
 40 45

The circuit arrangement of Fig. 6 shows the various stages thereof in conventionalized form. The detector is shown as preceded by cascaded radio frequency amplifiers, and followed by an audio amplifier. It is to be clearly understood that these radio frequency tubes may be the various stages of a superheterodyne receiver which precede the second detector; as, for example, shown in Fig. 1. In any case, the symbol D₁ designates the demodulator diode whose cathode includes the resistor 72 having one side thereof grounded. The cathode of the audio amplifier is connected to the cathode side of resistor 72, as disclosed in connection with Fig. 1. The direct current voltage component of the rectified signal currents is utilized for AVC action by transmitting it through resistor 71 to the AVC leads. The fixed bias diode D₂ has its anode connected to the resistor 71, and its cathode is connected to ground through the resistor 70.
 50 55 60 65

A condenser 74 is connected in shunt with the diode D₂, and the resistor 75 is connected in shunt with the diode D₂ and condenser 74. The negative lead of the power supply network is connected to the cathode side of resistor 75, and the voltage drop across resistor 70 furnishes the normal grid bias for the radio frequency tubes preceding the demodulator. To secure the benefits of graduated control on the cascaded amplifiers, the grid of the second controlled tube is
 70 75

connected to the point 75' on resistor 75, and the grid of the tube preceding the detector is connected to the point 75''. It will be noted that the cathodes of each of the controlled tubes is grounded, and that the AVC leads to the grids each include filter resistors.

The arrangements shown in Fig. 6 function in a manner similar to that described in connection with Fig. 1. The diode D₁ not only furnishes the AVC bias, but also supplies the audio signal for the succeeding audio amplifier. The resistor 75 is a bleeder resistor for the purpose of applying AVC bias to the successive grids of gradually diminishing negative values. The bleeder 75 in turn is connected to a point in the supply circuit which is below ground potential by the voltage drop across resistor 70. When the diode D₂ is conductive, then the voltage drop across resistor 70 furnishes the normal fixed bias for the various grids of the controlled tubes.

The resistor 71 is made sufficiently large not to interfere with the detection action occurring in the circuit including diode D₁. When no signals are received, the anode of diode D₂ is positive with respect to its cathode by the potential equal to the drops across resistors 70 and 72. This causes the diode D₂ to be conductive, and the anode side of the diode is at substantially the same direct current potential as the cathode side thereof. When signals are received, which are of an amplitude sufficient to just overcome the aforementioned voltage drops across resistors 70 and 72, then the diode D₂ becomes inactive, and the AVC action is the biasing element. Here, again, it is to be noted that there will be a slight biasing voltage developed across resistor 73, assuming that the resistor 73 causes an appreciable voltage drop, with the result that there will be a suppressor action for extremely weak signals.

In Fig. 7 is shown a modification of the arrangement in Fig. 6 wherein the diode D₂ is non-conductive for low signal intensities. It becomes conductive when signals are received which are strong enough to overcome the potential difference between points y and x. It will be observed that this is the reverse of the situation shown in Fig. 6, and is secured by connecting the diode D₂ in series between the bleeder 75 and resistors 71 and 73. It is believed that the operation and functioning of this modification will be obvious from the description given in connection with Fig. 6.

In both Figs. 6 and 7 the diodes D₁ and D₂ may be disposed in a single tube envelope. Furthermore, at least one of the diodes may be disposed in the envelope of another tube, as shown in connection with Fig. 3. While Figs. 6 and 7 disclose the application of different AVC voltages to the controlled tubes, it is within the scope of the present invention to more generally provide different initial voltages and different delay action to the controlled tubes.

In Fig. 8 there is shown a circuit diagram of a receiving system embodying such a circuit wherein the controlled tubes are given different delays and different initial voltages by means of a plurality of auxiliary diodes. Each of the controlled tubes 80, 81 and 82 is provided with self-bias networks 83, 84 and 85. The diode D₁ is the demodulator, and it is to be understood that the controlled tubes preceding it may be the customary superheterodyne receiver networks, or they may be amplifiers which are tunable through a common signal frequency range.

The audio voltage component developed across resistor 86 is fed to the succeeding audio amplifier, and the latter includes in its cathode circuit the resistor 87 which develops voltage e₁.

An intermediate point on resistor 86 is connected to three parallel bleeder resistors, the grid of tube 80 being connected to an intermediate point on the first bleeder resistor 88; the grid of tube 81 being connected to an intermediate point on the second bleeder resistor, and the grid of tube 82 being connected to an intermediate point on the third bleeder resistor 89. In order to explain the operation of this modification, the biasing actions in connection with tube 81 will be considered. The initial bias on this tube is equal to minus (e₃+e₂). The delay bias on tube 81 is equal to (e₁+e₂). The fraction of the AVC voltage applied to tube 81 is equal to

$$\frac{R_3}{R_1+R_2+R_3}$$

It is believed that the biasing actions with respect to tubes 80 and 82 will be clear from the explanation in connection with tube 81. Furthermore, it is pointed out that the point a in the circuit of diode D₁ need not be connected to the cathode of the succeeding audio amplifier, but may be tied to any available potential. The numerals 90, 91 and 92 designate the auxiliary diodes operatively associated with the parallel bleeder resistors.

In Fig. 9 there is shown a further modification wherein the present invention is applied to a circuit which will permit the control voltage on a given tube to be varied within predetermined limits as may be desirable to avoid undue distortion from one stage. The controlled tube 100 utilizes in its cathode circuit a self-bias network, and the voltage developed across the self-bias resistor is denoted by the symbol e₄. The diode demodulator D₁ has an intermediate point on its load resistor 101 connected through resistor 102 to the anode of an auxiliary diode D₂.

The cathode of the latter diode is connected to ground through a resistor which develops a voltage e₆, and the cathode of diode D₁ is connected to ground through a resistor which develops the voltage e₅. The diode D₂ is shunted by resistor 103, and an intermediate point thereon is connected to the cathode of a second auxiliary diode D₃. The anode of diode D₃ is connected to resistor 103 through a resistor which develops a voltage e₇. The cathode of diode D₃ is connected to the grid of the controlled tube through resistor 104.

The curve in Fig. 10 illustrates the biasing actions in Fig. 9. The voltage on the control grid of tube 100 varies as shown in Fig. 10, a variable negative bias being applied to the grid between negative bias values of constant intensity e_a and e_b. The values of these latter limiting constant negative bias values is designated in Fig. 10 in terms of the various voltages shown in Fig. 9. From Fig. 10 it will be observed that the AVC action applies a variable negative bias to the controlled tube between predetermined limits.

While I have indicated and described several circuit arrangements for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is not limited to the particular systems described herein, but that many additional modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. In a radio receiver provided with a signal demodulator including an electron emission element and a cold output electrode, a load impedance connected in circuit with said element and electrode, a signal transmission tube in said receiver which includes at least a signal grid, a cathode and an anode, the anode being coupled to the demodulator output electrode for the impression of signals upon the demodulator, said tube cathode being maintained at a predetermined fixed direct current potential, an automatic gain control connection between the control grid of said tube and the point on said load impedance adjacent the demodulator output electrode, a normal grid bias path connected between said control grid and a potential point which is at the same potential as the cathode of said signal transmission tube, said normal biasing path including in series a diode and a source of negative potential of a predetermined value, a second source of negative direct current potential having its negative terminal connected to said last named potential point and its positive terminal connected to the emission element side of said demodulator load impedance.

2. In a receiver as defined in claim 1, said diode having its cathode connected to the negative terminal of said first source of negative potential, and said demodulator comprising a diode.

3. In a receiver as defined in claim 1, said first and second potential sources comprising bleeder resistors connected in the power supply network of the receiver.

4. In a radio receiver provided with a plurality of cascaded signal transmission tubes, each tube including a cathode at ground potential, a demodulator diode including a load resistor between its anode and cathode, means connected between ground and the cathode side of said load resistor for maintaining the demodulator anode normally positive with respect to said grounded cathodes, means for applying a normal negative bias to the signal grids of said cascaded tubes, said last means including a diode having its anode connected to said signal grids, and its cathode connected to ground through a source of negative direct current potential, and a gain control connection between the said signal grids and a point on said load resistor which is at a negative direct current potential with respect to the demodulator cathode when signals above a predetermined amplitude are received.

5. In a receiver as defined in claim 4, an audio amplifier following said demodulator, and connections between the input electrodes of said audio amplifier and said first named means for maintaining the signal grid of the audio amplifier at a negative direct current potential with respect to the cathode thereof.

6. In a receiver as defined in claim 4, the electrodes of both said diodes being disposed within a common tube envelope.

7. In a receiver as defined in claim 4, additional means for impressing the direct current potential developed across said demodulator load resistor upon the signal grids in progressively decreasing manner.

8. In a radio receiver of the type utilizing a rectified alternating current supply network for energizing the tubes of the receiver, and said receiver being of a type including a plurality of cascaded signal transmission tubes followed by a demodulator tube, the improvement which comprises a connection between the cathode of

the demodulator and a point in said power supply network which is at a positive potential with respect to ground, a load resistor connected between the cold electrode of the demodulator and its cathode, the cathodes of said transmission tubes being maintained at ground potential whereby the demodulator cold electrode is normally positive with respect to ground, a signal grid biasing connection between the signal grids of said cascaded tubes and a point on said supply network which is negative with respect to ground, and a control connection between the cold electrode side of said demodulator load resistor and said grid biasing connection for rendering the latter inoperative to bias the signal grids when signals above a predetermined amplitude are received.

9. In combination with a wave transmission tube having at least a cathode, a wave input electrode and an output electrode, a wave demodulator diode having its electrodes coupled to the output electrode of said tube, a load resistor connected between the anode and cathode of said diode, means for normally maintaining the diode anode at a positive direct current potential with respect to the cathode of the wave transmission tube, additional means including a non-rectifying device of uni-directional conductivity for maintaining the wave input electrode of said tube at a negative direct current potential with respect to its cathode, and means responsive to a predetermined signal amplitude increase for rendering said additional means inoperative, and biasing said input electrode in direct proportion to the wave amplitude increase.

10. In a receiver as defined in claim 8, an audio amplifier following said demodulator tube, an audio connection between the input electrode of said audio amplifier and an intermediate point on said demodulator load resistor, and a bleeder resistor connected between said last named intermediate point and ground, there being a connection from a predetermined intermediate point on said bleeder resistor to a tuning indicator.

11. In a receiver as defined in claim 9, said additional means including a diode connected in series with a source of negative direct current potential, and said last named diode and the demodulator diode having their electrodes disposed in a common tube envelope.

12. In a receiver as defined in claim 9, an audio amplifier following said demodulator diode, and said additional means being connected to the input electrodes of said audio amplifier for maintaining the signal input electrode of the latter at a desired negative potential with respect to the cathode thereof.

13. In a receiver as defined in claim 9, an additional diode operatively associated with the said wave input electrode and said last named means for maintaining the said wave input electrode at a predetermined constant negative potential with respect to its cathode upon impression on said wave transmission tube of waves above a predetermined amplitude.

14. In a receiver as defined in claim 9, said last means including a diode, and said last diode also being included in said additional means.

15. In a radio receiver provided with a plurality of cascaded signal transmission tubes, each tube being provided with at least a signal control grid, a cathode, and an anode, a demodulator diode following the last of the cascaded tubes, said diode including a load resistor for developing direct current and audio frequency

components from received signal waves, gain control connections from the signal grids of the cascaded tubes to a point on the demodulator load resistor which is at a negative direct current potential with respect to the demodulator cathode potential when signals above a predetermined amplitude are received, each of said gain control connections additionally being connected to a point of negative direct current potential with respect to ground, and the cathodes of said cascaded tubes being connected to ground, additional means for maintaining the demodulator anode at a predetermined positive potential with respect to ground, each of said gain control connections additionally including a diode constructed and arranged to have its conductivity dependent upon the magnitude of the direct current potential of said negative point on the demodulator load resistor.

16. In combination with a signal transmission tube and a signal rectifier having its rectifying electrodes coupled to the said tube, a load resistor connected with said electrodes and across which a direct current voltage is developed by rectified signal currents, a biasing circuit for the input electrodes of said transmission tube comprising a direct current voltage source connected between said input electrodes with a device functioning to close the biasing circuit, and means for applying at least a portion of said developed voltage to the said input electrodes as a gain control bias, and additional means for applying at least a portion of said developed voltage to said device in a sense to cause the biasing circuit to become ineffective when the signal intensity assumes a predetermined value.

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