Jan. 4, 1938. G. W. FYLER 2,104,616

HIGH FREQUENCY RECEIVER

Filed March 11, 1936

Fig. 1.

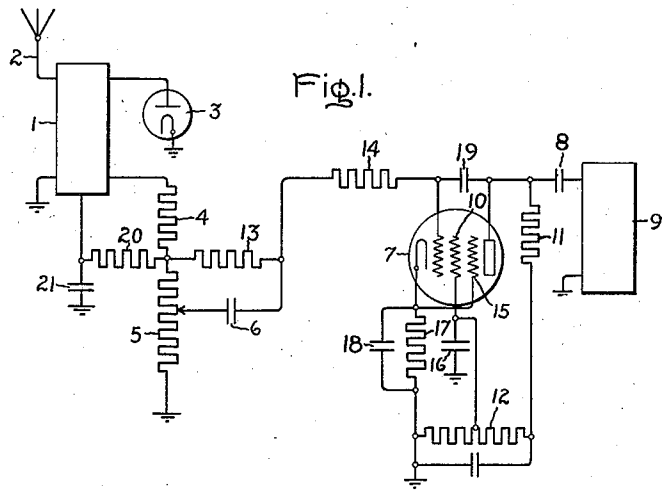


Fig. 2.

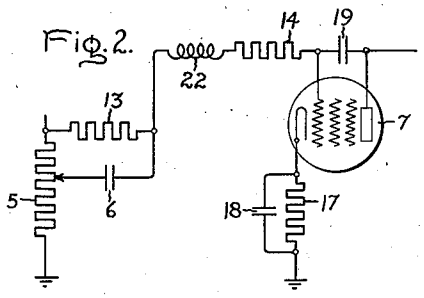
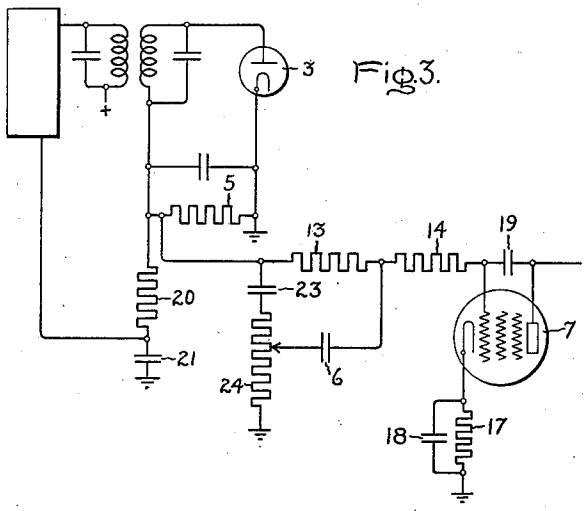


Fig. 3.



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HIGH FREQUENCY RECEIVER

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Application March 11, 1936, Serial No. 68,181

1 Claim. (Cl. 250—20)

My invention relates to high frequency receivers and more particularly to radio receivers provided with means for maintaining the output volume constant irrespective of the intensity of received signals.

Receivers of the type referred to commonly are provided with means for varying the amplification of one or more amplifiers in response to the intensity of the received signal thereby to maintain the output constant. This means that the amplifiers have high amplification at times when the signal is weakest, as during periods of fading and when tuning between stations, with the result that undesired noise currents, "man made" static and the like, are undesirably amplified at such times. One of the objects of my present invention is to provide improved automatic means to reduce the transmission through the receiver of the undesired noise currents during periods of reception of weak signals.

The undesired currents referred to are predominantly currents in the high frequency portion of the audio range. In accordance with my invention means are provided whereby in response to a reduction in intensity of received signals the attenuation of these high frequency currents relative to low audio frequency currents is automatically increased.

One of the objects of my invention is to provide means whereby this result may be effected without substantial increase in complication of the apparatus and with a maximum of economy.

A still further object of my invention is to provide means utilizing a discharge device which is utilized for other purposes in the receiver, as in the capacity of an audio amplifier, to effect the desired automatic control of the attenuation of currents of high audio frequency.

Still a further object of my invention is to provide means whereby such an amplifier which is utilized to effect desired attenuation of high frequency currents may also be utilized to maintain the output from the receiver constant notwithstanding variations in intensity of input to the receiver.

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 represents an embodiment of my invention and Figs. 2 and 3 represent modifications thereof.

Referring to the drawing, I have shown therein a radio receiver 1 employing an antenna 2, said receiver being of any suitable type, such as one involving a number of stages of tuned radio frequency amplification, or one of the conventional superheterodyne type, and in which the amplified oscillations are supplied to a suitable detector. This detector, in the particular form of the invention illustrated, comprises the diode 3 to which high frequency oscillations are supplied through means included in the receiver and through a circuit which includes load resistances 4 and 5 represented on the drawing. Audio frequency currents representing voice or musical sounds, are of course produced upon the load resistance 5 by reason of detection of the high frequency oscillations supplied thereto and are supplied through a coupling condenser 6 to the grid of an electron discharge device 7 which may be employed as an audio amplifier. The amplified audio oscillations are supplied from the anode of this device through condenser 8, and any additional stages of audio amplification which may be desired, to the loudspeaker or other output device. The output equipment including any additional amplifiers are represented in the drawing by the rectangle 9. The condenser 6 is connected to a variable contact on the potentiometer 5 whereby the intensity of received signal currents supplied to discharge device 7 for amplification may be varied manually.

The electron discharge amplifier 7 may be supplied with anode operating voltage through resistor 11 from a potentiometer, or bleeder resistance 12, the screen grid 10 of this discharge device being connected to an intermediate point on this potentiometer. The screen grid is, of course, connected to ground through a by-pass capacitor 16. A portion of the operating bias for the control grid of the discharge device is provided by resistance 17 which is connected in a common portion of the grid and anode circuits of the discharge device, this resistance being by-passed for audio frequency currents by condenser 18. The discharge device 7 may also, if desired, include a suppresser grid 15 adjacent the anode and which is connected directly to the cathode. A condenser 19 is also connected between the control grid and anode for purposes presently to be described.

It is of course desired that the audio output from the radio receiver be maintained constant, or within a predetermined desired range of varia-

tion, during variations in intensity of the received signal electromotive force, and to effect this the direct current potential, which also appears upon resistance 5, as a result of detection of the high frequency oscillations, is supplied to the grids of any amplifiers employed in the receiver through a circuit including a series resistance 20 and a shunt condenser 21, this circuit being the conventional automatic volume control circuit now widely used in radio receivers. Resistance 20 and capacity 21 comprise a filter for attenuating audio frequency variations in the unidirectional electromotive forces which may appear upon resistance 5 and thereby prevent their being supplied to the grids of the high frequency amplifiers.

In order additionally to control the constancy of the output with respect to the intensity of the received carrier wave, the unidirectional electromotive force on resistance 5 is also supplied to the grid of discharge device 7 through resistances 13 and 14. Thus upon increase in the intensity of the received carrier wave the unidirectional voltage upon resistance 5 also increases thus driving the grid of discharge device 7 more negative with respect to the cathode and hence reducing the amplification of the discharge device. This discharge device preferably is one of the tapered grid, or variable mu type such as is commonly used in amplification stages in which automatic volume control is effected. This device may be, for example, one of the 550 type or one of the more recent 6K7 type. The total operating bias voltage for the grid thereof comprises that on resistance 5 plus that on resistor 17. In the absence of received signal it comprises substantially only that on resistance 17. This resistance is of course proportioned in accordance with the electron discharge device employed. By proper proportioning of the circuit elements and by proper adjustment of the bias voltage upon the discharge device 7, including the portion produced by resistance 17, the output thereof may be maintained substantially constant over a wide range of variation of received signal intensity notwithstanding such variations in voltages on resistance 5 as may occur. It will be understood that the regulating effect of the automatic volume control circuit employed in connection with the portion of the receiver indicated at 1 may not be so complete as to render the voltage on resistance 5 as constant as desired. By utilizing the connection 13, 14 the amplification of tube 7 may be so controlled that desired constancy of output is obtained.

As previously pointed out the discharge device 7 produces maximum amplification when the received signals have minimum intensity. This is by reason of the fact that the unidirectional electromotive force on resistance 5 is then small and the grid of the discharge device is less negative with respect to the cathode. This is also true of the discharge devices controlled by the automatic volume control circuit 20, 21 with the result that during reception of weak signals, as during fading, or during periods when the tuning control is adjusted between stations as when tuning from one station to another, the over all amplification of the receiver is extremely high. Any undesired noise currents received at such times are therefore greatly amplified and cause objectionably loud response by the loudspeaker. These undesired noise currents are predominantly of high frequency, that is of frequencies high in the audio range, and in order that they shall not be unduly amplified resistance 14 and capacity 19 are provided in accordance with my invention. This resistance 14 is so proportioned relative to the capacity connected between the grid and cathode of the discharge device and the mu of the tube as to attenuate these currents.

As previously stated this discharge device is one of the variable mu type and one in which the transconductance gm varies with the unidirectional voltage applied to the grid.

The dynamic input capacity between the grid and cathode of this discharge device may be expressed approximately by the equation

$$C_g' = (1+u')$$

C_{gp} where C_g' represents the dynamic input capacity between the grid and cathode, u' represents the actual amplification of the discharge device and C_{gp} represents the capacity between the grid and anode of the discharge device, this capacity comprising the external capacity connected between the grid and anode and the inherent internal capacity, which in screen tubes is very small. The actual amplification u' of the discharge device is the product of the transconductance g_m of the discharge device and R_0 where R_0 represents the plate load alternating current resistance. This resistance R_0 comprises in the drawing principally the resistance 11 since the alternating current input resistance to the equipment 9 is assumed to be high. It will therefore be seen that when the transconductance g_m of the discharge device is largest the actual amplification u' is largest and from the equation, the grid to cathode capacity is also largest, with the result that by proper choice of resistance 14, this resistance, together with the other resistances in the grid circuit of the discharge device, may be made to combine with the grid to cathode capacity of the discharge device to form an automatically variable resistance capacity filter. This filter may be effective to produce desired attenuation of currents in the high frequency portion of the audio range during periods when the received signals are weakest and substantially ineffective to produce attenuation of currents of these frequencies during reception of strong signals. That is, resistance 14 may be so proportioned relative to the maximum value of capacity between the grid and cathode of the discharge device that desired attenuation of high frequency currents is produced during reception of weak signals. Then upon reception of strong signals, by reason of the reduction in grid to cathode capacity this attenuation of high audio frequency currents is greatly reduced. That is the frequency range in which the filter is most effective is above the frequency range which it is desired to receive, or in other words the cut off frequency of the filter is automatically increased in response to increase in intensity of the received carrier wave.

The frequency attenuation characteristic of a resistance capacity filter is of course of well known form, the attenuation increasing somewhat gradually with increase in frequency in the upper range while it is substantially constant in the lower range. If it be desired that the filter have a sharper cut off frequency and greater attenuation at the higher frequencies this may be effected by inserting an inductance in series with the resistance 14. This modification of my invention is shown in Fig. 2 in which the inductance 22 is inserted in series with the resistance 14, the remaining elements of the figure having the reference numerals of Fig. 1.

It is sometimes not desirable to provide a vari-

able contact directly upon the load resistance of the diode as shown in Figs. 1 and 2 since this resistance carries the direct current component of the rectified signal. With such an arrangement undesired noise currents are likely to be set up in response to variation of the contact along the resistance thereby producing unpleasant sounds from the loudspeaker. To avoid this effect the arrangement of Fig. 3 may be employed. In this figure the load resistance 5 is shunted by an alternating current path comprising capacity 23 and resistance 24. The grid of the audio stage is now connected to the load resistance 5 for direct currents exactly as before. For alternating currents, however, the condenser 6 is connected to a variable contact on resistance 24. Since there is no unidirectional potential on this resistance the undesired noise currents above referred to are avoided.

With such an arrangement, however, it is necessary that resistance 24 be sufficiently large that the total alternating current load on the diode 3 is substantially equal to the direct current load. But when this resistance is large, unless proper precautions are taken, it becomes an appreciable portion of the resistance capacity filter above referred to with the result that as the variable contact is moved along a portion of this resistance it undesirably effects the attenuation of high frequency audio currents produced by the resistance capacity filter. This will be understood if it be assumed, for example, that the variable contact is moved from the grounded terminal of resistance 24 upward. The first effect is to increase the resistance of the resistance capacity filter and to increase the attenuation of high frequency currents produced thereby. This is desirable. But as the contact is moved from about the middle portion of the resistance on upward it then reduces the resistance in the resistance capacity filter. This is by reason of the fact that a low resistance path to ground now exists from the variable contact through the upper portion of resistance 24, condenser 23, and resistance 5. Resistance 5 preferably is of about 250,000 ohms whereas resistance 24 may be about two megohms. The total resistance of this path reduces as the variable contact moves upward with the result that attenuation of high frequency currents is again reduced. This is undesirable. It has been found, however, that this effect may be avoided or minimized by making resistance 14 large, as a major fraction of a megohm, and the condenser 19 small.

It will thus be seen that the amplification of the system to currents in the high and low frequency portions of the audio range varies in different relations with respect to the intensity of received signals, the amplification of high frequency currents increasing much less rapidly than that for low frequency currents upon decrease in received signal intensity.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto since the different modifications may be made both in the circuit arrangement and instrumentalities employed, and I contemplate by the appended claim 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:

In combination, a detector having a direct current load resistance, a high resistance connected in shunt therewith through a capacitor, an amplifier having an output circuit, a grid, and a cathode, said grid and cathode being connected across at least a portion of said load resistance for direct current, and across at least a portion of said high resistance for alternating currents whereby the amplification of said amplifier to said alternating currents is varied in accordance with the unidirectional potential on said load resistance, means whereby the capacity between said grid and cathode varies with variation in said unidirectional potential, a high impedance in series between said high resistance and said grid, said impedance being proportioned relative to changes in capacity between said grid and cathode produced by said unidirectional potential to produce desired attenuation of high frequency signal currents during periods when the amplification of said amplifier is largest and said impedance being sufficiently high that said attenuation is not appreciably affected by the portion of the whole of said high resistance across which said grid and cathode is connected.

GEORGE W. FYLER.