Jan. 10, 1939. H. P. THOMAS 2,143,722

HIGH FREQUENCY SIGNALING SYSTEM

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Fig. 1.

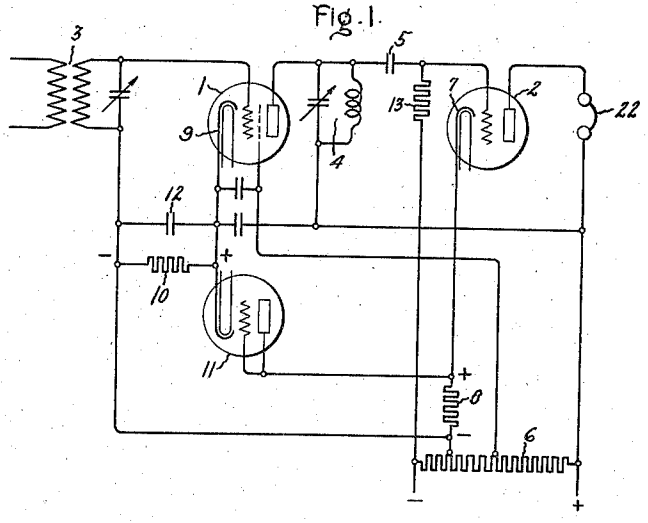
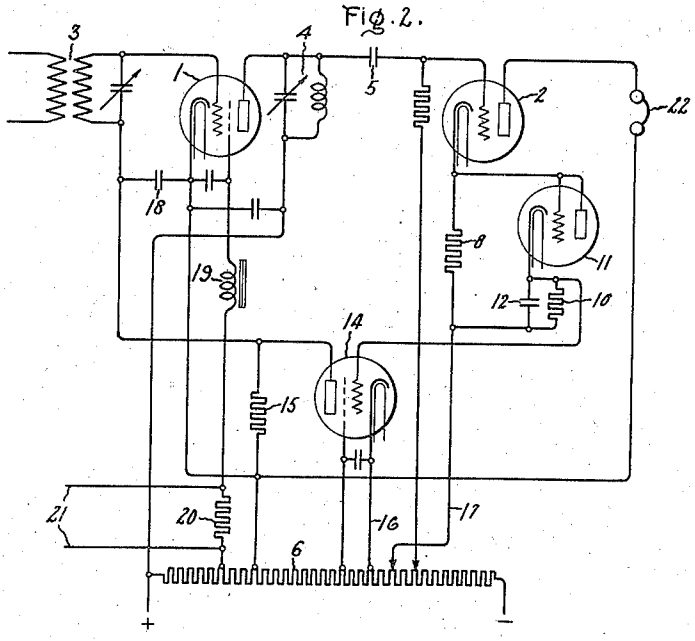


Fig. 2.



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HIGH FREQUENCY SIGNALING SYSTEM

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12 Claims. (Cl. 250—20)

My invention relates to high frequency signaling systems and more particularly to automatic volume control means therefor.

It has for one of its objects to provide an automatic volume control system which is particularly adapted for use in receivers which are used primarily in connection with systems in which the transmitted carrier wave is controlled by the signals transmitted. Such a system is shown, for example, in United States Patent No. 1,696,566 issued December 25, 1928, to Emmet F. Carter, and is commonly used for carrier current communication over power lines. In such systems the carrier wave is transmitted only during the transmission of signals and is interrupted during brief interruptions in the signals such as between words and sentences in ordinary speech.

Automatic volume control means, as ordinarily employed, decrease the sensitivity of the receiver in response to increase in the intensity of the received carrier, the sensitivity of the receiver being varied substantially in accordance with the envelope of the carrier and just slow enough to prevent removal of the signal modulation of the carrier. When such an automatic volume control device is used in a receiver which responds to a carrier wave which is controlled by the signal as above described, it will be apparent that the sensitivity of the receiver will be maximum during interruptions in the carrier as between words and sentences in the speech transmitted, and will be reduced during receipt of signal impulses. This means that extraneous currents, such as static, background noise currents, line disturbances, etc., which may reach the receiver during intervals between words, find the receiver at its maximum sensitivity and thus these currents are undesirably amplified in the receiver.

One of the objects of my invention is to provide an automatic volume control receiver for the reception of voice modulated carrier waves and in which the sensitivity of the receiver is reduced during brief interruptions on the carrier, as between words and syllables of speech, notwithstanding that weak currents are received in the receiver during these interruptions.

A further object of my invention is to provide an automatic volume control receiver the sensitivity of which is rapidly responsive to increases in intensity of received carrier and slowly responsive to decreases in intensity of received carrier, and in which the rates of response of the sensitivity control equipment to increases and decreases of the carrier are independently controllable.

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 Figs. 1 and 2 represent different embodiments of my invention.

Referring to Fig. 1 of the drawing I have represented therein a high frequency receiver employing electron discharge devices 1 and 2. The electron discharge device 1 is connected to operate as an amplifier of high frequency oscillations received through transformer 3, which is indicated as tuned, and to repeat these oscillations to the grid of the electron discharge device 2 which is connected to operate as a detector. The input to the transformer 3 may be connected to the output of earlier tuned stages of the receiver, or in a power line carrier current receiver, to the power conductors, through any suitable coupling apparatus. The anode circuit of the amplifier is tuned as indicated at 4 and is coupled to the grid of the detector through the usual coupling condenser 5. The circuits of the discharge devices are arranged to be energized from a potentiometer 6 which is connected across a suitable source of unidirectional potential, the anodes of both of the discharge devices 1 and 2 being connected to the positive end of the potentiometer. The cathode 7 of the discharge device 2 is connected to an intermediate point on the potentiometer through a resistance 8, and the cathode 9 of discharge device 1 is connected to the same point on the potentiometer 6 through a resistance 10. Between the cathodes of the two discharge devices is connected a third electron discharge device 11. This device includes a cathode which is connected to the terminal of resistance 10 adjacent to the cathode 9 and an anode which is connected to the terminal of resistance 8 adjacent to cathode 7. This device may include a grid which is conventionally indicated as short circuited to the anode. In shunt to the resistance 10 is a large condenser 12 this parallel combination of capacitance and resistance being included in the grid circuit of the amplifier 1 whereby the amplification of the discharge device 1 is controlled by the charge upon the condenser 12.

In the operation of the device as thus described it will be observed that the anode current of the detector 2 flows through the resistance 8 in such

a direction as to produce a potential on this resistance having polarity as indicated on the drawing. This potential causes the anode of discharge device 11 to become positive with respect to its cathode and thus current flows through the discharge device 11 in such a direction as to produce a charge upon condenser 12 of such polarity as to drive the grid of amplifier 1 negative. The detector 2 is of the grid bias type the grid being connected through the ordinary grid leak resistance 13 to the negative end of the potentiometer 6 and hence the current in the resistance 8 increases in accordance with the intensity of the received carrier wave. The charge on the condenser 12 is thus caused correspondingly to increase with the intensity of the carrier whereby the grid potential on the amplifier 1 becomes increasingly negative which in turn reduces the amplification of the discharge device and tends to maintain a substantially constant volume of signal received in the headphones or other signal device 22, which may be included in the anode circuit of the detector.

Upon decreases in the sensitivity of the received carrier the potential on resistance 8 is reduced and the condenser 12 starts to discharge. Since electron discharge device 11 is unidirectionally conductive and passes current only from its anode to its cathode, the condenser 12 finds but a single discharge path, namely, the resistance 10. This resistance 10 is of a fairly high value so that a considerable time interval is required for discharge of the condenser, this time interval being sufficient to maintain the amplification of the amplifier 1 reduced during the intervals between words, sentences, etc., in ordinary speech. In this way extraneous noises such as static, background noises, line disturbances, etc., which may be received through transformer 3, particularly when this transformer is connected to the lines of a power distribution system, during the intervals between words and sentences in speech, find the sensitivity of the receiver substantially reduced by the automatic volume control equipment and thus their effect in the signal device 14 is substantially reduced. Of course after a sufficient time interval has elapsed following the reception of a speech or signal modulated carrier the condenser 12 becomes discharged through the resistance 10 and the receiver is restored to its normal high standby sensitivity.

The use of discharge device 11 between resistances 8 and 10 permits the use of different values of resistances at these two points of the circuit. That is, the rates of charge and discharge of the condenser are independently controllable. The resistance 8 may be of a sufficient value to cause condenser 12 to charge in response to increases in intensity of the carrier wave at about the rate of increase of the energy level of the carrier, i. e. at about the rate common to automatic volume control receivers of the prior art. The value of this resistance does not affect the rate of discharge of the condenser in response to decrease in intensity of the carrier wave, the latter being determined by resistance 10 which may be sufficiently high to retard the discharge for a desired period, which may be several seconds or minutes but which should not be so long as to prevent the device from compensating for the ordinary variations in intensity which it is intended to compensate for. In power line carrier current apparatus the principal function of the volume control device is to compensate for differences in intensity of carrier received from stations at different distances. In this application, and my invention is in nowise limited thereto, the period determined by resistance 10 may be a minute or more. As I have ordinarily used my invention, the receiver is restored to its normal sensitivity in a period of from thirty seconds to a minute.

The form of the invention shown in Fig. 1 is a very satisfactory one for use in a carrier current power line communication system where the receiver is located at a point fairly distant from the nearest transmitter or where means, not shown, are provided for protecting the receiver from carrier waves of high intensity such as may be produced by a transmitter located in the same station and connected to the power line. In the event of reception in the receiver of an extremely strong carrier, such as that from the associated transmitter in the same station, sufficient rectification of the carrier is likely to take place in the grid circuit of the discharge device 1 to cause a very high charge to build up on the condenser 12. This means that a considerable time interval is required for this condenser to discharge after the transmitter has been rendered inoperative by removal of signal currents, for example. The receiver thus is rendered inoperative by the condenser 12 for a considerable period following each operation of the transmitter. This necessitates a delay between the transmission of a message and the next subsequent reception of a message, which in ordinary two way conversation is very objectionable.

The form of the invention shown in Fig. 2 includes means whereby this objection is avoided. This form of the invention differs from that shown in Fig. 1 in that an additional discharge device 14 is provided, this discharge device being included in the circuit between the grid of discharge device 1 and the capacitance resistance combination 10, 12, and arranged to act as a direct current amplifier. The positive end of resistance 10 is connected to the grid of discharge device 14 and the negative end is connected to an intermediate point on the potentiometer 6 so that as current in the detector increases the grid potential on the discharge device 14 correspondingly increases thereby causing an increase in anode current flowing in the discharge device 14. This anode current passes through a resistance 15 in the anode circuit of discharge device 14 which resistance is also included in the circuit between the grid and cathode of the discharge device 1 and is so poled as to produce a negative charge upon the grid of the discharge device 1 when current flows through the resistance 15.

It will be observed that the grid of the discharge device 14 is normally biased negatively by an amount corresponding to the potential on that portion of potentiometer 6 between conductors 16 and 17. This potential is sufficient normally to reduce the anode current in the discharge device 14 to an extremely small or zero value. Upon increase in the intensity of the received carrier beyond a predetermined value the condenser 12 becomes charged as previously described in connection with Fig. 1 thereby varying the potential on the grid of discharge device 14 in a positive direction, which in turn causes an increase in current in the resistance 15, and a variation in bias potential on the grid of discharge device 1 in the negative direction. This of course reduces the sensitivity of the receiver sufficiently to maintain a substantially constant volume of signal in the receiving device 14.

As thus described any rectification which may occur in the grid circuit of discharge device 1 upon receipt of extremely strong carrier wave signals, as from a carrier transmitter in the same station in which the receiver is located, has no effect upon the condenser 12 and the resistance 10.

It will of course be observed, however, that the resistance 15 is itself connected in shunt to the condenser 18 in the grid circuit of amplifier 1. This condenser, however, is of a relatively small value and serves as a bypass for high frequency energy. The time constant of operation of the volume control device, however, is determined by the condenser 12 and resistance 10 exactly as described in connection with Fig. 1.

While the discharge devices shown in the drawing may be of any suitable type, I have conventionally indicated them as of the heater cathode type, the heating circuit being omitted from the drawing for purposes of simplicity. Similarly the discharge devices 1 and 14 are indicated as of the screen grid type, the screen grids being supplied with suitable positive potential from the potentiometer 6. The screen grid circuit of the discharge device 1, in Fig. 2, includes an iron core audio frequency inductance 19 and a resistance 20, the latter of which is provided with leads extending to terminals 21. These connections may extend to an associated transmitter to receive potential when the transmitter is in operation sufficient to drive the screen grid of discharge device 1 negative thereby to render the receiver inoperative during operation of the associated transmitter. The inductance 19 has for its purpose to prevent the occurrence of clicks in the headphones 22 in response to the application of voltage to the resistance 20 by the associated transmitter.

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 both in the circuit arrangements and instrumentalities employed may be made. I 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 carrier wave receiver adapted to receive signal modulated carrier wave impulses, of a carrier wave rectifier having a resistance in the direct current path thereof, a condenser, means to charge said condenser in response to voltage on said resistance, means to control the sensitivity of said receiver in response to voltage on said condenser whereby said sensitivity is controlled in response to the intensity of the rectified carrier, means to prevent discharge of said condenser through said resistance and a discharge path for said condenser having sufficiently high resistance to maintain said receiver insensitive during the period between impulses substantially as determined by a preceding impulse.

2. In combination, a carrier wave electron discharge amplifier having a grid, means to supply a carrier wave to be amplified to said grid, a condenser, means to control the charge on said condenser in response to the intensity of carrier waves amplified by said amplifier, a discharge path for said condenser having sufficiently high resistance to render the charge on said condenser substantially less susceptible to reductions in carrier wave intensity than to increases therein, means to control the bias on said grid in accordance with the charge on said condenser, and means to prevent said condenser from being charged due to grid rectification in said electron discharge amplifier.

3. The combination, of an alternating current amplifier, sensitively controlled means therefor, said means comprising a condenser, a resistor, and a unilaterally conducting device, means to rectify alternating currents amplified by said amplifier and to supply the rectified currents to said resistor, means to charge said condenser from said resistor through said unilaterally conducting device, means to control the sensitivity of said amplifier in accordance with the voltage on said condenser, and means whereby said condenser discharges upon decrease in intensity of said alternating currents at a rate slow relative to the rate of charge of said condenser upon increase in intensity of said alternating currents.

4. In a receiving system for voice modulated carrier waves, an audio output circuit, means including a resistance connected in a direct current path of said system and responsive to the intensity of received modulated carrier waves for maintaining a relatively constant intensity of audio currents in said output circuit, means including a condenser arranged to be charged by the voltage across said resistance for rendering said receiver insensitive during predetermined intervals after said carrier is interrupted, and means for preventing discharge of said condenser through said resistance when said carrier is interrupted.

5. In a receiving system for voice modulated carrier waves, a high frequency amplifier having a control grid, means connected in said system and including a resistance connected in a direct current path of said system for impressing a control potential on said control grid which varies in accordance with the intensity of received modulated carrier waves, means including a condenser arranged to be charged by the voltage across said resistance for rendering said receiver insensitive during predetermined intervals after said carrier is interrupted, and means including a unilateral conducting means connected between said resistance and said condenser for preventing discharge of said condenser through said resistance during the periods when said carrier is interrupted.

6. In a receiving system for signal modulated carrier wave impulses, an output circuit, means including a resistance connected in a direct current path of said system and responsive to the intensity of received modulated carrier waves for maintaining a relatively constant intensity of signal waves in said output circuit, means including a condenser arranged to be charged by the voltage across said resistance and a second resistance connected to said condenser for rendering said receiver insensitive for predetermined intervals after said carrier is interrupted, and means for preventing a discharge of said condenser through said first-mentioned resistance when said carrier is interrupted.

7. In a receiving system for voice modulated carrier waves, an output circuit, a high frequency amplifier having a control electrode, a resistance connected in a direct current path of said system, means for varying the voltage across said resistance in accordance with the intensity of received modulated carrier waves, a circuit for impressing said potential on said control electrode, a condenser connected to said circuit and ar-

ranged to be charged by the potential across said resistance, means including said condenser and a second resistance shunting said condenser for rendering said receiver insensitive during predetermined intervals after said carrier is interrupted, and means for preventing a discharge of said condenser through said first-mentioned resistance when said carrier is interrupted.

8. In combination, a carrier wave receiver having an audio output circuit and including an electron discharge amplifier having a control grid, a condenser, means to control the bias on said grid in accordance with the charge on said condenser, means responsive to the intensity of received carrier waves for controlling the charge on said condenser and to maintain a relatively constant intensity of audio currents in said audio output circuit, means to retain the charge on said condenser when said carrier is interrupted sufficiently to render said receiver insensitive for predetermined periods at least of the duration of periods between words and sentences in ordinary speech, and means including an electron discharge device connected between said last-named means and said control grid to prevent said condenser from being charged due to grid rectification of high intensity carrier wave in said amplifier discharge device.

9. In combination, a carrier wave receiver including an electron discharge amplifier having a control grid, a condenser arranged to impress a control potential on said control grid, means for charging said condenser, means to delay discharge of said condenser for a period long relative to intervals between words in ordinary speech, and means including an electron discharge device connected between said condenser and said amplifier control grid to prevent said condenser from being charged due to grid rectification of received high intensity carrier waves in said electron discharge amplifier.

10. The combination in a carrier wave receiver of a carrier wave rectifier having a resistance in the direct current path thereof, a condenser, means to charge said condenser in response to voltage on said resistance, means to control the sensitivity of said receiver in response to voltage on said condenser whereby said sensitivity is varied in response to the intensity of the rectified carrier, a high resistance discharge path for said condenser, said path having a resistance value higher than that of said first resistance thereby to maintain said receiver insensitive during the period between impulses to an extent determined by a preceding impulse, and means including a unilateral conducting device for confining discharge of said condenser to said high resistance discharge path during periods when said carrier is interrupted.

11. The combination, in a carrier wave receiver adapted to receive carrier wave impulses, of a carrier wave rectifier having a resistance in the direct current path thereof, a condenser, means to charge said condenser in response to voltage on said resistance, means to control the sensitivity of said receiver in response to voltage on said condenser whereby said sensitivity is controlled in response to the intensity of the rectified carrier, means to prevent discharge of said condenser through said resistance and a discharge path for said condenser having sufficiently high resistance to maintain said receiver insensitive between impulses to an extent determined by a preceding impulse.

12. The combination, in a carrier wave receiver adapted to receive carrier wave impulses, of a carrier wave rectifier having a resistance in the direct current path thereof, a condenser, a discharge device, means to charge said condenser through said discharge device in response to voltage on said resistance, means to control the sensitivity of said receiver in response to voltage on said condenser whereby said sensitivity is controlled in response to the intensity of the rectified carrier, means effective when said carrier is interrupted to prevent discharge of said condenser through said discharge device and to delay the discharge of said condenser between impulses sufficiently to maintain the sensitivity of said receiver substantially as determined by the last preceding impulse.

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