

Feb. 18, 1936.

H. O. ROOSENSTEIN

2,031,072

METHOD OF AND MEANS FOR SIGNALING

Filed May 5, 1932

2 Sheets-Sheet 1

Fig. 1

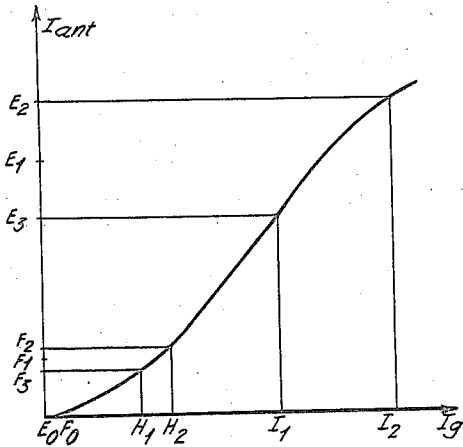


Fig. 2

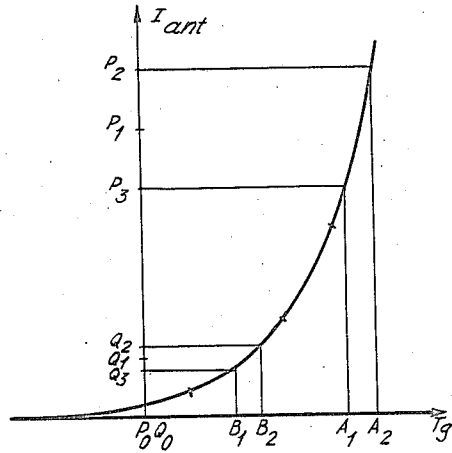
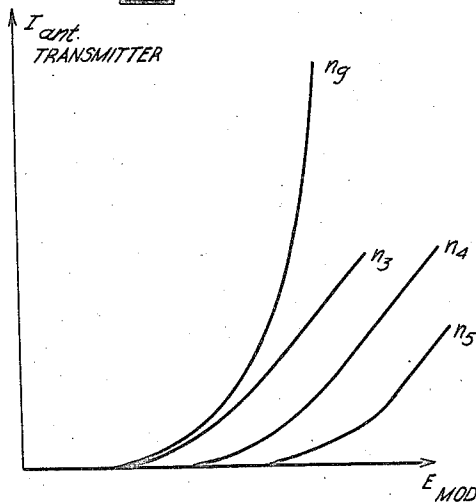


Fig. 3



INVENTOR
HANS O. ROOSENSTEIN
BY *H. S. Grover*
ATTORNEY

Feb. 18, 1936.

H. O. ROOSENSTEIN

2,031,072

METHOD OF AND MEANS FOR SIGNALING

Filed May 5, 1932

2 Sheets-Sheet 2

Fig. 3

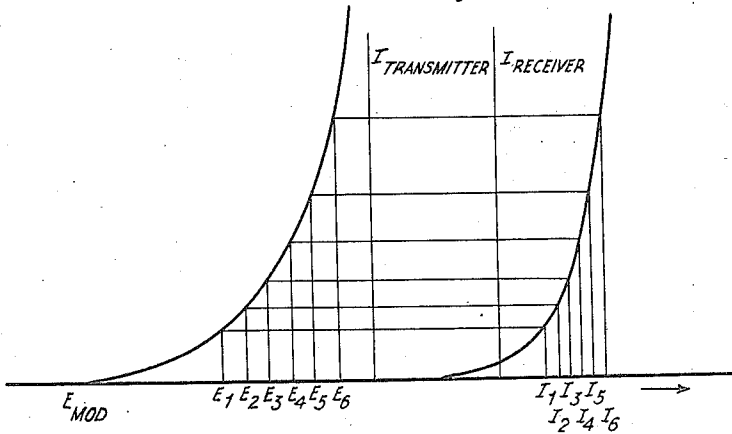


Fig. 4

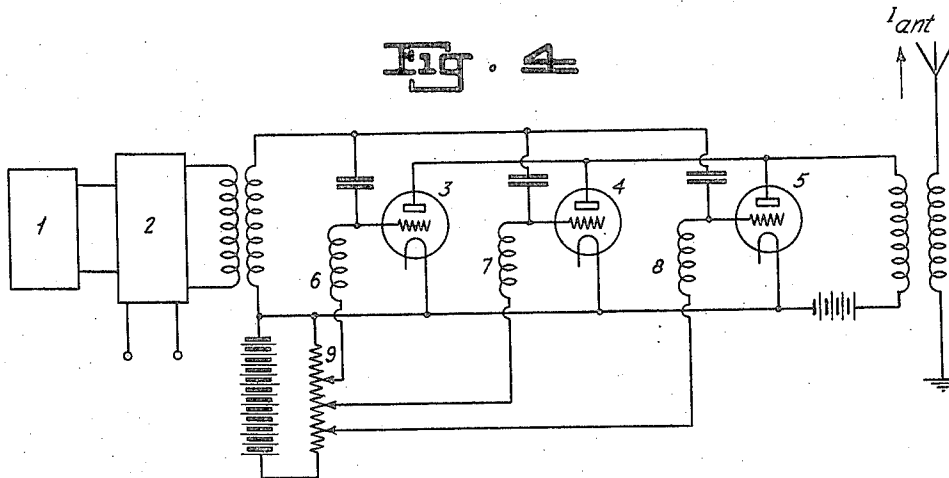
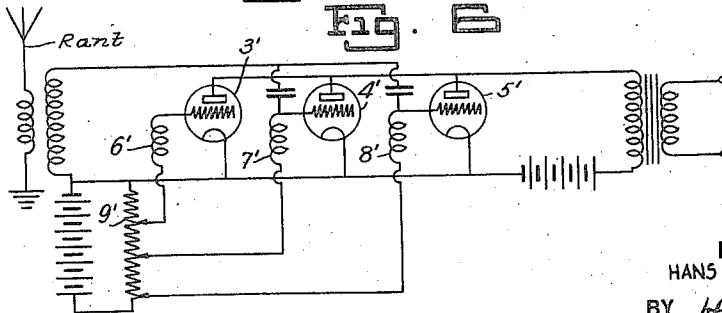


Fig. 5



INVENTOR
HANS O. ROOSENSTEIN
BY *H. S. Hoover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,031,072

METHOD OF AND MEANS FOR SIGNALING

Hans Otto Roosenstein, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application May 5, 1932, Serial No. 609,421
In Germany May 18, 1931

12 Claims. (Cl. 250—2)

In order to reduce disturbances caused by fading broadcast reception or for volume control in transportable receiver sets, a great many different ways and means have been suggested in the prior art which, when added to the receiver set, cause the overall amplification to become automatically adjusted in such a way that the volume remains practically constant and stable. Such automatic regulations of the signal strength involve the drawback that in most instances they cause a considerable complication in the receiver set.

The method hereinafter to be disclosed, which constitutes the object of the present invention, is based upon a recognition of the fact that for the purpose of securing constant reception volume really no automatic amplification or gain control is required in the set, in fact, that it is feasible to impart to the transmitter such a modulation curve that undistorted reception becomes possible whose volume, within wide limits, will be independent of the incoming field intensity. For undistorted reproduction it is necessary that the modulation curve of the transmitter and the modulation characteristic of the receiver should be congruous curves.

A more complete understanding of the invention will be had by reference to the drawings, in which:

Figures 1, 2, 3, and 5 are curves illustrating the manner in which fading of the signals is reduced; and,

Figure 4 illustrates one arrangement whereby such reduction is assured;

Figure 6 illustrates a circuit arrangement whereby signal modulated carrier waves from any source may be demodulated in accordance with the present invention.

In the normal receiving method the modulation characteristic of the transmitter and the demodulation curve of the receiver are approximately straight lines. The latter graph is shown in Figure 1. Referring to the same, E_1 , E_0 denote the average or median incoming volume or signal strength of the modulated signal, E_0 , E_2 , the maximum volume, E_0 , E_3 , the minimum amplitude thereof. The direct current variation, which is caused by modulation of the incoming signal in the receiver, is found from the demodulation curve to be I_1 to I_2 . Now, the assumption shall be made that, as a result of fading, the amplitude of the signal decreases from E_0 , E_2 to F_0 , F_1 , the maximum and minimum amplitudes, in analogy with the previous case being represented by F_0 ,

F_2 and F_0 , F_3 . The ratio between maximum amplitude and minimum amplitude is given by the degree of modulation of the transmitter which is assumed to be constant. Except for what is known as selective fading, it will not be influenced by ordinary fading phenomena. As a result there is:

$$E_0E_1:E_0E_2:E_0E_3=F_0F_1:F_0F_2:F_0F_3$$

Similarly, as in the first example, the ensuing direct current variation is H_1 to H_2 , and for a rectifier curve as shown I_1 to $I_2 > H_1$ to H_2 .

If, in spite of the fact that the field intensity falling upon the receiver decreases to a lower amount, the audio frequency current variation in the receiver set is to stay unvaried, then, according to the invention, the curve shown in Figure 1 must be an exponential function:

$$I_{ant} = A e^{B_1 g} \quad 20$$

where A and B are constants which are a function of the apparatus. Now, this exponential curve is represented in Figure 2 where again P_0P_1 is the mean value of the modulated signal, P_0 , P_2 the crest volume, and P_0P_3 the minimum amplitude thereof. If, in a demodulation curve, the input field intensity P_0P_1 decreases to Q_0Q_1 as a result of fading, the output volume $A_1A_2=B_1B_2$ remains perfectly constant. This is explainable also mathematically seeing that:

$$1. A_1A_2=P_0A_2-P_0A_1=\log \text{ nat } P_0P_2-\log \text{ nat } P_0P_3$$

Then:

$$A_1A_2=\log \text{ nat } \frac{P_0P_2}{P_0P_3} \quad 35$$

Similarly:

$$B_1B_2=\log \text{ nat } \frac{Q_0Q_2}{Q_0Q_1}$$

However, since:

$$3. P_0P_2/P_0P_1 = Q_0Q_2/Q_0Q_1 = \frac{1+k}{1-k} \quad 40$$

where k =degree of modulation of transmitter, it is found that

$$B_1B_2=A_1A_2 \quad 45$$

In other words, reception is a function only of the degree of modulation, not of the amplitude. However, for the sake of insuring freedom from distortion in reproduction the same demand must be made of the modulation curve of the transmitter.

Referring to Figure 3, the modulation curve of the transmitter and the rectifying characteristic of the receiver as regards the values of the an-

tenna currents are represented to the same scale. It will be seen from the illustration that a modulation potential E_1 at the transmitter results in a direct current in the receiver of a value of I_1 . In the exponential form of the modulation characteristic of the transmitter, as will be noted, reproduction of modulation faithful as to amplitude is secured. It will be seen from Figure 3 that similar differences in modulation potential in the transmitter (E_1, E_2, E_3, E_4 ; etc) result in similarly large rectified currents in the receiver set (I_1, I_2, I_3, I_4 ; etc.).

An embodiment of a transmitter of the kind here disclosed is shown by way of example in Figure 4. 1 denotes the pilot valve, 2 is the modulator stage. The amplifier stage comprises three or more tubes 3, 4, 5, etc. whose grid direct current potentials are derived by way of radio frequency chokes 6, 7, and 8, for example, from a potentiometer 9. The grids of tubes 3, 4 and 5 are each coupled by way of a coupling condenser, as shown, to an inductance which is in turn coupled to the output of the modulator 2. The modulated and exponentially controlled energy is impressed on the antenna, as shown, for transmission.

Figure 5 shows the power curves, N_3, N_4, N_5 , of the tubes 3, 4, 5, as a function of the grid alternating current potential furnished from the modulator stage 2. N_6 is the aggregate power curve which results from an addition of the amounts of N_3, N_4 , and N_5 . If the different grid biasing potentials have been judiciously chosen, it is possible to obtain a modulation characteristic that will have an exponential form throughout a large part or range.

In order to secure an exponential rectifier characteristic in the receiver, recourse may be had to ways and means similar to those described for the transmitter and which are predicated upon the additive or aggregation effect of several characteristics of different tubes. Such an arrangement has been shown in Figure 6. The circuit of Figure 6 is, as stated above, similar in many respects to the circuit of Figure 4. In the circuit of Figure 6, elements corresponding to similar elements in the modulator circuit of Figure 4 have been designated by the same numerals or letter primed. In the circuit of Figure 6, carrier waves modulated at signal potential from any source, such as for example the antenna shown, are impressed in the input electrodes of the demodulator tubes 3', 4', 5' in the manner shown and described in detail in connection with Figure 4. The rectifying characteristic of several tubes when combined is of an exponential form, as indicated above, and the demodulated signal when rectified appears in the output of tube 5', from which it may be utilized directly or after low frequency amplification. It has, moreover, been found in practice that receivers wherein the super-regenerative principle is employed result practically in the same volume for different input field intensities, in other words, these receivers possess the above indicated and stipulated exponential form of the rectifying characteristic.

Another embodiment is insured by paralleling a plurality of transmitter valves or modulation or demodulation tubes having dissimilar values of $1:\mu$. Also, in this instance, by suitable dimensions, it is possible to obtain a form of characteristics that will exhibit an exponential shape throughout a large part thereof. Instead of paralleling several tubes with this end in view it is feasible also to get along with a single tube whose $1:\mu$ differs for different points of the character-

istic. Tubes of this kind, as is known in the art, are obtained if the pitch of the cylindrical spiral, which is used as a grid, changes continuously in longitudinal direction.

Having thus described my invention and the operation thereof, what I claim is:

1. The method of reducing fading effect on the transmission of undulatory electrical energy which includes the step of, modulating said waves to a depth which varies exponentially as the amplitude of the modulating potential varies.

2. The method of reducing fading effect on the transmission of undulatory electrical energy on which signals have been impressed by a transmitter including a thermionic tube which includes the step of, passing said undulatory electrical energy through said thermionic tube, and varying the amplification characteristics of said tube exponentially as the depth of modulation on the repeated signal varies.

3. The method of demodulating signal modulated oscillations which includes the steps of receiving said signal modulated oscillations, and producing an energy component representative of the signal modulations of said oscillations which varies exponentially as the amplitude of the received radio frequency oscillations.

4. The method of signaling by means of oscillations which are to be signal modulated and transmitted between two spaced points and of maintaining the strength of the signals substantially constant at the point of reception irrespective of attenuation or fading which may take place during said transmission which includes the steps of, modulating said oscillations to a depth which varies exponentially as the amplitude of the signal varies, radiating said modulated oscillations, receiving said modulated oscillations, and demodulating said signal modulated oscillations into components, the energy of one of which varies exponentially as the amplitude of the received radio frequency oscillations.

5. Signaling means including, means for eliminating undesirable effects of transmission of said signals on the amplitude of said signals including, a source of signal modulated oscillations, a load circuit, a plurality of thermionic tubes each having anode, cathode and control grid, an inductance connected with the output circuit of said source of signal modulated oscillations, a second inductance having one terminal connected to the cathode of each of said tubes, said second inductance being coupled to said first named inductance, a separate capacity connecting the free terminal of said second inductance to the control grid of each of said tubes, a third inductance having one terminal connected to the anode of each of said tubes and the other terminal connected to the cathode of each of said tubes, said third inductance being coupled to said load circuit, a source of potential, a resistance in parallel with said source of potential, and separate circuits each including a choking inductance connecting the control grid of each of said tubes to a different point on said resistance.

6. The method of receiving signals and of eliminating fading effects on the received signal by means of a signal demodulator which includes applying said signals to the input of said demodulator, and operating the same so that the direct current component in the output thereof varies as the logarithm of the radio frequency voltage impressed on the input, whereby the audio frequency output amplitude over a wide range of carrier voltages depends only on percent modulation.

tion of the received carrier and not on actual carrier wave voltage level.

7. The method of signaling by means of a carrier on which signal modulations are impressed and a receiver including a demodulator on which said signal modulated carrier is impressed for demodulation and for reducing the effect of fading on said carrier, and distortion in the signal, which includes the steps of varying the amplitude of the carrier by modulating potentials so that the factor

$$\frac{1+K}{1-K}$$

varies as e signal amplitude and operating said demodulator so that the amplitude of the direct current component in the output thereof varies as the log of the amplitude of the radio frequency voltage impressed on the input (where $1+K$ is maximum radio frequency voltage and $1-K$ is minimum radio frequency voltage).

8. The method of signaling which includes the steps of producing a carrier wave and varying the ratio of the maximum to the minimum radio frequency amplitude of the carrier wave exponentially as the amplitude of the signal varies.

9. In a radio receiver of modulated radio frequency waves wherein a plurality of tubes have their input and output circuits respectively connected together, each of said tubes having different input potential-output current characteristic curves, the method of receiving which comprises impressing the waves in like phase upon the input circuits of all the tubes and utilizing portions of each of the characteristic curves of said tubes to obtain a desired resultant characteristic curve which varies substantially logarithmically.

10. The method of treating intercepted signal modulated radio frequency waves so as to amplify the intercepted waves in accordance with the

degree of modulation thereof without regard to amplitude of said waves which comprises applying the incoming energy simultaneously to a plurality of different relays arranged to operate within predetermined limits along their respective input potential-output current characteristic curves and biasing the relays so that as a whole they constitute in effect a single tube having a logarithmic input potential-output current characteristic curve for the whole range of the signals.

11. In a radio receiver of modulated radio frequency waves, a plurality of tubes having their input and output circuits respectively connected together, each of said tubes having different input potential-output current characteristic curves, means for impressing signal energy waves in like phase upon the input circuits of all the tubes, and means to supply biasing voltages of successively different values upon the series of tube inputs to produce in the combined output circuit a resulting characteristic which varies substantially logarithmically.

12. In combination with a source of signal modulated radio frequency waves, a plurality of thermionic tubes having different input potential-output current characteristic curves, each tube being provided with an input circuit, a common output circuit for all of said tubes, means for simultaneously impressing signal waves from said source in like phase upon the input circuits of all the tubes, means for biasing said tube input circuits so that the tubes become operative successively in accordance with the amplitude of the signal waves, the biasing potential applied to the input circuits of the tubes being related to the characteristics of the various tubes so that the total resultant characteristic curve varies substantially logarithmically.

HANS OTTO ROOSENSTEIN.