

March 23, 1943.

M. KATZIN

2,314,707

SIGNALING SYSTEM

Filed March 7, 1941

Fig. 1.

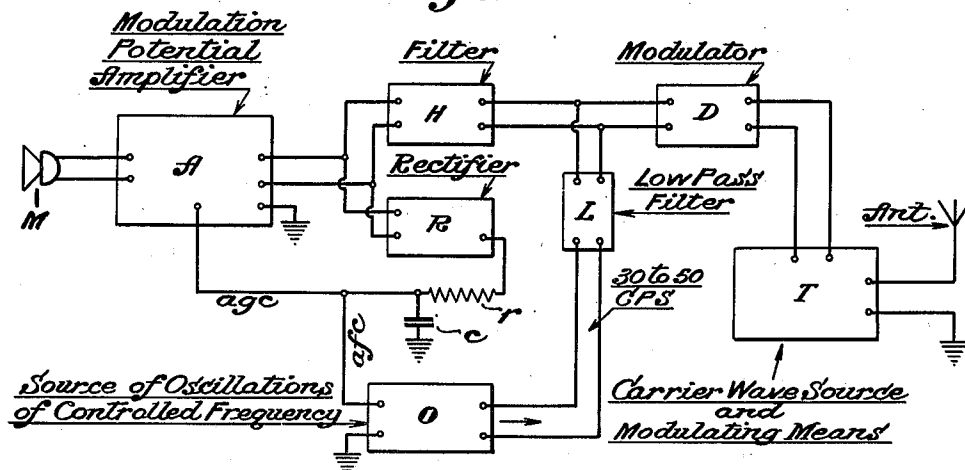


Fig. 2.

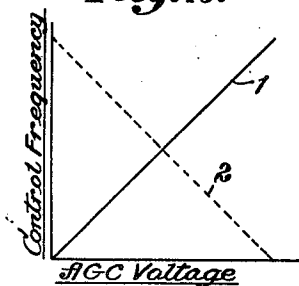


Fig. 4.

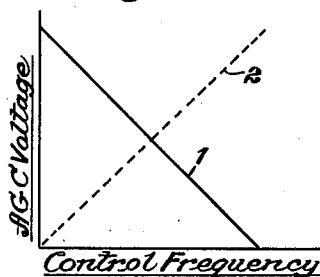
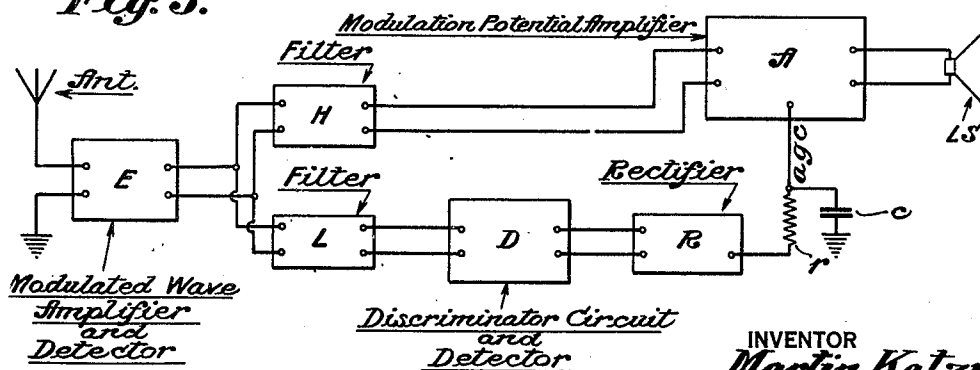


Fig. 3.



INVENTOR
BY *Martin Katzin*
H. Grover
ATTORNEY

UNITED STATES PATENT OFFICE

2,314,707

SIGNALING SYSTEM

Martin Katzin, Riverhead, N. Y., assignor to
Radio Corporation of America, a corporation
of Delaware

Application March 7, 1941, Serial No. 382,181

8 Claims. (Cl. 250—6)

This application discloses a new and improved method of and means for producing wave energy modulated fully in accordance with signal potentials and also modulated in accordance with the mean amplitude of the signal potentials. At the receiver the benefits of high percentage modulation are obtained at all times. The modulations in accordance with the mean amplitude of the signal potentials are derived and used for automatic gain control purposes to thus restore the derived signal potentials to their original relative amplitudes. In a preferred embodiment the modulation of the carrier in accordance with the mean amplitude is in accordance with oscillations the frequency of which is a function of the mean amplitude of the signal potentials.

In describing my invention reference will be made to the attached drawing wherein Figures 1 to 4 depict schematically a system of communication arranged in accordance with my invention. Figure 1 illustrates by block diagram a transmitter system including means for modulating a carrier substantially 100% by signaling potentials and also impressing on said carrier modulations in accordance with the mean amplitude of the signal potentials; Figure 2 is a curve showing a characteristic of a portion of the equipment in Figure 1; Figure 3 illustrates by block diagram a receiving means arranged in accordance with my invention; while Figure 4 is a curve showing a characteristic of a portion of the equipment in Figure 3.

Referring to Figure 1, M is a source of modulating potential of the desired type, here shown as a microphone, connected to the input of an audio frequency amplifier A. The amplifier A may include a number of tube stages of amplification. The output of amplifier A is connected to high-pass (or band-pass) filter H and to rectifier R. Amplified modulating potentials are thus supplied to the filter H and to the input of the rectifier R. Amplifier A is provided with automatic-gain-control means controlled from the output of rectifier R through a time constant circuit *r, c*. This control means may include means for applying potentials over the line AGC to a control electrode in one or more of the amplifier tubes of A. This same gain-controlling voltage is also used to control the frequency of operation of oscillation generating means in O, as will be described more fully below. The oscillations at the output of O are passed through low-pass filter L. The output circuits of filters H and L are connected together and to modulator D. The amplified modulating potentials

and oscillating potentials are supplied to the modulator D. The modulator D is connected to transmitting means T which includes carrier wave producing means which provides a carrier that is modulated by the output of modulator D.

Oscillator O is used to provide the auxiliary, or control, frequency used at the receiver for automatic gain control purposes. Thus auxiliary frequency may, for example, occupy a portion of the audio-frequency spectrum below the lowest frequency of intelligence to be transmitted, say below 30 to 50 cycles. Oscillator O may, for example, be of the reactance tube controlled type such as shown in Seeley Patent No. 2,121,103, June 21, 1938, or of the type disclosed in Crosby Patent No. 2,065,565, December 29, 1936. The oscillator O and control means is similar to those used in automatic frequency controlled receivers. The final control frequency may be obtained most conveniently by having the direct current control voltage from rectifier R, supplied by way of line *afc*, control a reactance tube impedance or equivalent means to thereby vary the frequency of a high frequency oscillator in O in accordance with the direct current potential variations. These controlled high frequency oscillations are then heterodyned to the desired very low audio frequency of correspondingly varied frequency, by means of a fixed frequency auxiliary oscillator. These oscillations of fixed frequency may be derived from the carrier wave frequency generated in transmitter T or may be generated in a separate oscillator. Filters H and L have their cut-off frequencies at the lowest frequency of intelligence to be transmitted, say 30 to 50 cycles.

The operation of the transmitting arrangement of Figure 1 is then as follows: Sound waves actuating microphone M are converted into electrical vibrations which are then amplified by audio-frequency amplifier A. Due to the provision of automatic gain control means, the output of amplifier A is maintained substantially constant, so that transmitter T may be operated at substantially 100 per cent modulation continuously.

The direct current AGC voltage which operates to maintain the output of amplifier A substantially constant also operates oscillation generating means in O to vary the frequency of the control frequency oscillations supplied from O to L in accordance with variations in the volume level of the sound waves impinging on microphone M. The relation between the direct current AGC voltage and the control frequency pro-

duced by the means in O may be as shown in Figure 2. Curve 1 shows the control frequency increasing uniformly with the AGC voltage. Another possible characteristic is shown by the dashed curve 2 which indicates the control frequency decreasing uniformly with the AGC voltage. For example, in the method of obtaining the control frequency as described above by heterodyning a controlled high frequency oscillator to the final low audio frequency, the characteristic of curve 1 would be obtained by choosing the heterodyning frequency at the lower end of the range of the high frequency oscillations, while the characteristic of curve 2 would be obtained by placing the heterodyning frequency at the upper end of this range.

The receiving device shown in Figure 3 consists of an antenna ANT coupled to a receiver E comprising radio frequency amplifiers or the same with heterodyning means with an IF amplifier. The receiver E includes a final detector or demodulator which reproduces the transmitted modulation. The output of receiver E is fed to high-pass (or band-pass) filter H and to low pass filter L. The output of filter H is amplified by audio frequency amplifier A, which is provided with automatic gain control means, and then reproduced by loud speaker LS. From the output of filter L the oscillations of varying frequency developed in O are passed to a frequency modulated wave demodulator D. This demodulator D may include a discriminator circuit and detector wherein the frequency variations of the oscillations O are changed to corresponding amplitude variations and demodulated. For example, I prefer to use here a demodulator of the type disclosed in Crosby Patent No. 2,229,640, dated January 28, 1941, or Seeley Patent No. 2,121,103, dated June 21, 1938, or Conrad Patent No. 2,057,640, dated October 13, 1936. Frequency variation detecting means of the type shown in Hansell Patent No. 1,813,922, July 14, 1922 may also be used as the detecting means in D. The demodulating means in D translates frequency variations into amplitude variations. The output of D is rectified by rectifier R, and the resulting direct current potentials are used to control the gain of amplifier A through time constant circuit rc. The direct current potentials developed in r are used to control the gain of one or more tube amplifiers included in amplifier A.

The operation of the system shown in Figure 3 may be described as follows: Antenna ANT intercepts the radiated signals which are treated in the usual manner in receiver E up to the point where they are normally subjected to audio frequency amplification. Following the final detector in E the received modulation band is separated into the control frequency band and the intelligence band by means of filters L and H respectively. The control frequency operates on discriminator D, the output of which has an amplitude which is dependent on the value of the control frequency. The output is then rectified by R and used to control the gain of amplifier A, which receives the intelligence band of frequencies passed by filter H. Thus, although the transmitter T emits substantially constant percentage modulation the provision of the control frequency enables the gain of the receiving system to be varied in inverse relation to the volume level of the original sound waves. The final sound waves emitted by LS may therefore be made to be a faithful reproduction of the original. The characteristic of discriminator D is preferably as

shown in Figure 4. Curve 1 of Figure 4 shows the AGC voltage decreasing uniformly with control frequency, corresponding to curve 1 of Figure 2. Another characteristic is shown by the dashed line curve 2 of Figure 4, which corresponds to curve 2 of Figure 2. Here as in Figure 1 the characteristic 1 or 2 can be obtained as desired by properly choosing the heterodyning frequency. In the transmitter the characteristic 2 can be obtained by reversing the polarity of the control potentials supplied to O. At the receiver the gain control potentials at the rectifier output may be reversed to obtain the characteristic indicated at 2 of Figure 4.

I claim:

1. The method of signaling which includes the steps of generating a carrier wave, modulating said carrier wave in accordance with signal potentials, controlling the amplitude of said signal potentials to obtain substantially full modulation of said carrier wave by said signal potentials, generating alternating potentials the frequency of which is proportional to the mean amplitude of the signal potentials, and modulating said carrier wave by said generated alternating potentials.

2. The method of signaling which includes the steps of generating a carrier wave, modulating the amplitude of said carrier wave in accordance with signal potentials, controlling the amplitude of said signal potentials to obtain continuous substantially full modulation of said carrier wave by said signal potentials, generating alternating potentials the frequency of which is a function of the mean amplitude of the signal potentials, and modulating the amplitude of said carrier wave by said generated alternating potentials.

3. The method of demodulating carrier wave energy continuously modulated substantially 100% by signal voltages and also modulated in accordance with potentials characteristic of the mean amplitude of the said signal voltages which includes the steps of demodulating said carrier wave energy to derive components characteristic of both of said modulations, separating the components characteristic of said last modulations from the components characteristic of said first modulations, amplifying said components characteristic of said first modulations and controlling the amplification of said first modulations substantially solely in accordance with variations of said components of characteristic of said separated components characteristic of said last modulations.

4. The method of signaling which includes the steps of generating a carrier wave, modulating said carrier wave in accordance with signal potentials, controlling the amplitude of said signal potentials to obtain substantially full modulation of said carrier wave by said signal potentials, generating oscillations the frequency of which is proportional to the mean amplitude of said signal potentials, modulating said carrier wave by said generated oscillations, receiving said carrier waves so modulated, demodulating said carrier wave to derive the modulation components, amplifying the modulation components corresponding to said first modulations of said carrier, and controlling said amplification in accordance with the modulation components corresponding to said last modulation of said carrier.

5. The method of signaling which includes the steps of generating a carrier wave, modulating the amplitude of said carrier wave in accordance with signal potentials, controlling the amplifica-

tion of said signal potentials to obtain continuous substantially full modulation of said carrier wave by said signal potentials, modulating the amplitude of said carrier wave by voltage the frequency of which is a function of the mean amplitude of said signal potentials, transmitting said modulated carrier wave, receiving said carrier wave so modulated, demodulating said carrier wave to derive the signal potentials and the voltages of varying frequency, subjecting said voltages of varying frequency to a frequency demodulation process to derive voltage characteristic of the mean amplitude of said signal potentials, amplifying the derived signal potentials, and controlling said amplification in accordance with the voltages derived by said frequency demodulation process.

6. Wave modulating means comprising a source of signal potentials, a source of carrier waves to be modulated, an amplifier including automatic gain control circuits coupling said source of signals to said source of carrier waves to be modulated, a controlled oscillator for generating potentials the frequency of which varies in accordance with the mean amplitude of said signal potentials, and circuits for modulating said carrier oscillations in accordance with said last named potentials.

7. In a signaling system, a source of signal potentials, a source of carrier waves to be modulated, an amplifier including automatic gain control circuits coupling said source of signal potentials to said source of carrier waves to be modu-

lated, circuits for generating potentials the frequency of which varies in accordance with the mean amplitude of said signal potentials, circuits for modulating said carrier wave in accordance with said generated potentials, connections for transmitting said modulated carrier wave, circuits for receiving and demodulating said carrier wave to derive the signal potentials and said generated potentials, an amplifier of controllable gain for amplifying the derived signal potentials, and circuits for controlling the gain of said last named amplifier in accordance with said derived generated potentials.

8. In a system for receiving and demodulating carrier wave energy modulated substantially 100% by signal voltages and also modulated in accordance with potentials the frequency of which is representative of the mean amplitude of the signal voltages, wave receiving amplifying and demodulating circuits, a first filter coupled to said circuits for selecting components characteristic of the signal voltages, an amplifier of controllable gain coupled to said filter, utilization means coupled to said amplifier, a second filter coupled to said first named circuits for selecting components characteristic of the potentials representative of the mean amplitude of the signal voltages, a frequency discriminator circuit coupled to said last named filter and a rectifier coupling said discriminator circuit to said amplifier of controllable gain.

MARTIN KATZIN.