Sept. 18, 1928.

R. K. HONAMAN

1,684,445

SIGNALING SYSTEM

Filed July 12, 1926

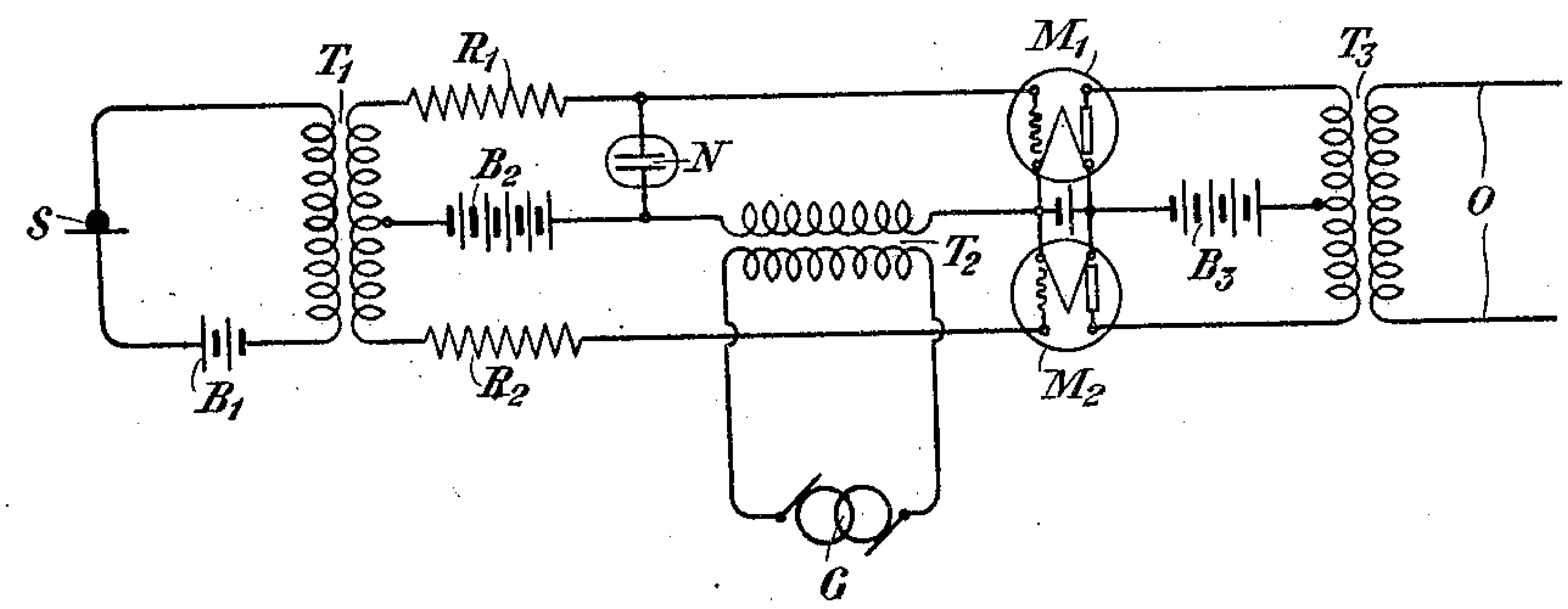

Fig. 1

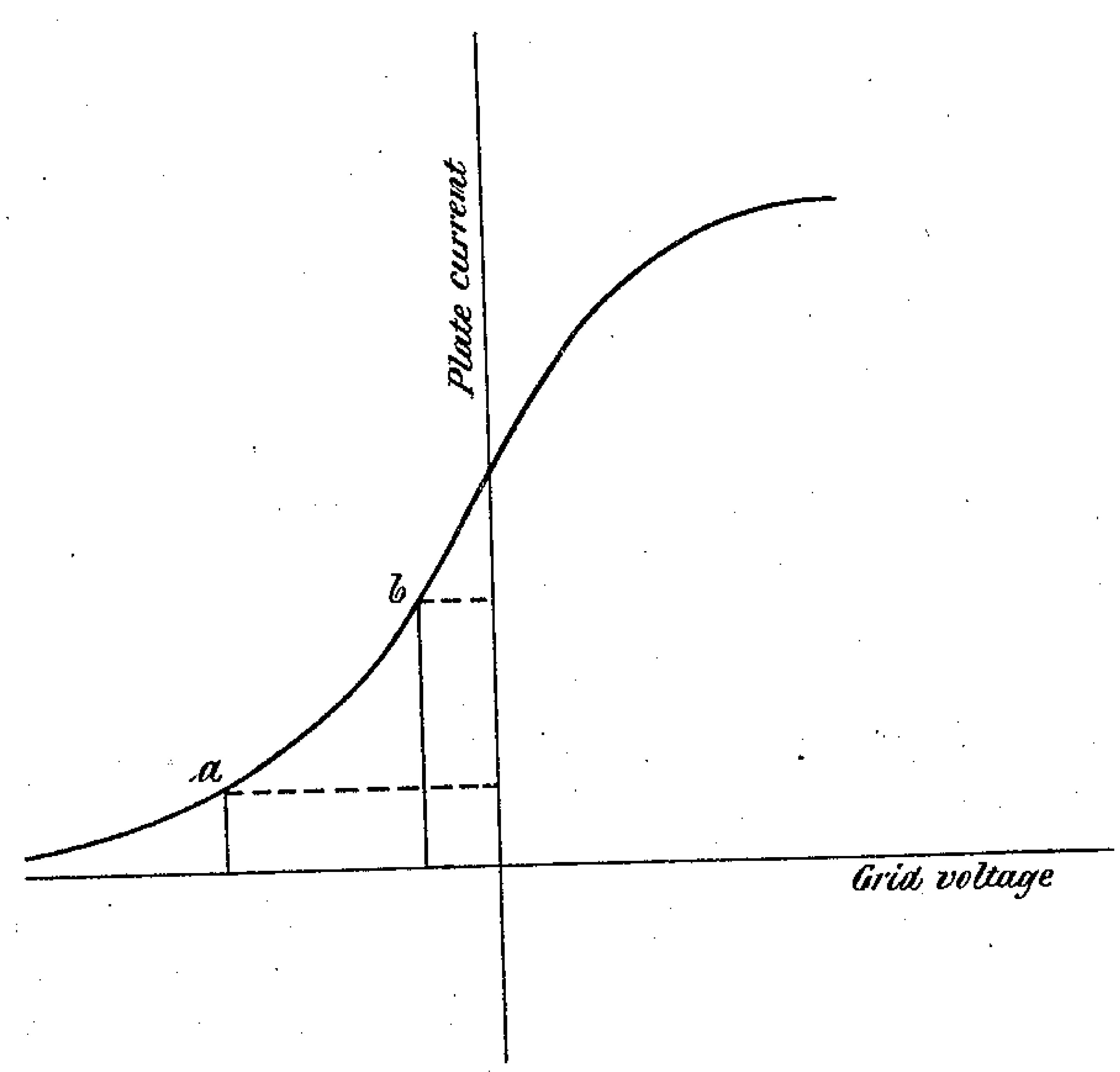

Fig. 2

INVENTOR
R. K. Honaman
BY
[signature]
ATTORNEY

Patented Sept. 18, 1928. **1,684,445**

UNITED STATES PATENT OFFICE.

RICHARD K. HONAMAN, OF BLOOMFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

Application filed July 12, 1926 Serial No. 122,016.

This invention relates to signaling systems, and particularly to arrangements in such systems for minimizing noise.

In high frequency transmission systems, such as radio broadcasting and carrier systems, in which a carrier frequency modulated by low frequency signals is transmitted, noise currents having frequencies within the range used for transmission are introduced into the transmitting medium and give rise to noise at the receiving station of the system. This noise results mainly from the beating of the carrier frequency by the noise currents introduced into the transmitting medium. Under certain conditions, the components of the noise currents, which are within the limits of audibility, are easily heard at the receiving station.

During intervals in a broadcasting program of news, music, or the like when no low frequency signals are modulated on the carrier frequency, as, for example, during the quiet intervals in the program, noise of this nature is particularly objectionable because of the fact that the noise stands out during these intervals. On the other hand, during periods in the program when the low frequency signals are modulated on the carrier frequency, the noise may be submerged by these low frequency signals.

As stated above, noise becomes audible at the receiving station during the quiet intervals in the program, and results from the interaction of the carrier frequency and the noise currents introduced into the transmitting medium from extraneous sources. Certainly, if the carrier frequency can be cut off during these quiet intervals, the noise will be greatly reduced, rendering these intervals substantially quiet at the receiving station. Furthermore, the carrier frequency serves no useful purpose during these quiet intervals.

It is therefore an object of this invention to provide arrangements suitable for transmitting a carrier frequency when there are low frequency signals or other modulating energy to be modulated thereon, and for substantially suppressing the carrier frequency when there are no such low frequency signals or other modulating energy to be modulated thereon.

While the nature of the invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figure 1 represents one embodiment of the invention, and in which Fig. 2 represents a characteristic curve of a vacuum tube showing the interrelation of plate current and grid voltage.

In Fig. 1, there is shown a transmitter S, or other source of low frequency signals, arranged in a series circuit with a battery B_1 and the primary winding of a transformer T_1. The transformer T_1 connects the circuit of the source of low frequency signals S to a duplex modulating system having two three-element thermionic tubes M_1, and M_2, each having a filament, a grid and a plate, the filaments being heated to an electron-emitting temperature by a common battery. The tubes M_1 and M_2 are preferably similar and equal in their structure and characteristics, and certainly may be replaced by a single duplex tube having a single filament, two grids and two plates. The input circuits of these tubes M_1 and M_2 are arranged in parallel with respect to the secondary winding of transformer T_2, which winding is in series with a battery B_2 in the common conductor of the input circuits of these tubes. The secondary of transformer T_1 consists of two windings which may, for example, be wound in the same direction, one in the input circuit of the tube M_1 and the other in the input circuit of the tube M_2. The output circuits of these tubes are also connected through the primary windings of a transformer T_3 in parallel with respect to a common plate battery B_3. The secondary winding of transformer T_3 is connected to an output circuit O.

The primary winding of the transformer T_2 has a generator G connected thereto, which generates, for example, the carrier frequency to be employed in the system. By virtue of the connection between the generator G and the transformer T_2 the grids of the tubes M_1 and M_2 are both in phase with respect to the carrier frequency transmitted by generator G. The oscillations of the carrier frequency will therefore be impressed in the same directions on the input circuits of these tubes, and under normal conditions the grids of these tubes will be equally biased negatively by battery B_2. Equal currents therefore flow in the output circuits of the tubes M_1 and M_2, but these currents are oppositely directed by the primary windings of the transformer T_3. Consequently, these currents effectively balance and neutralize each other, and no current flows in the output circuit O.

In former arrangements of duplex translating circuits, when low frequency signals were generated at the source S, the grid of one of the tubes M_1 or M_2 became positive while the grid of the other tube became negative, so that the resistance of one tube decreased while the resistance of the other increased. This then caused an increase in the current flowing in the output circuit of the tube in which the grid became positive and a corresponding decrease in the current flowing in the output circuit of the tube in which the grid became negative. The tubes M_1 and M_2 were actuated only when low frequency signals were impressed on the grids of these tubes.

The present invention comprises arrangements for substantially suppressing the carrier frequency of the generator G when no low frequency signals are transmitted by the transmitter S, and for transmitting the carrier frequency of the generator G modulated by the low frequency signals transmitted by the transmitter S when such signals are generated. A neon tube N, or other discharge device, is accordingly connected in the input circuit of one of the tubes, M_1. This neon tube has a break-down potential which is above the potential of the battery B_2. When the potential across the terminals of the neon tube is less than its break-down potential, it will have a very high impedance, and when the potential across the terminals of the neon tube is equal to, or less than, its breakdown potential, it will have a moderate impedance. Because of this fact the neon tube will be ineffective in the system until the potential across its terminals is greater than its break-down potential. And until this break-down potential is applied to the terminals of the neon tube N, there will be practically no effective current flowing in the primary windings of the transformer T^3, and consequently no current will be transmitted to the output circuit O.

The neon tube N is so arranged in the system that when low frequency signals are transmitted by the source S, a potential will be generated across the terminals of the upper winding of the transformer T_1, so that the cumulative potential of the battery B_2 and that generated across the terminals of the upper secondary winding of the transformer T_1 will be greater than the break-down potential of the neon tube N. When this occurs current will flow from the battery B_2 through the neon tube N in a local circuit which includes the battery B_2, the upper secondary winding of the transformer T_1, a resistance R_1 and the neon tube N. The neon tube N will therefore shunt the grid and filament of the tube M_1 so that the grid of the tube M_1 will not be biased negatively as much as the grid of the tube M_2. Consequently more current will flow in the output circuit of the tube M_1 than will flow in the output circuit of the tube M_2. Inasmuch as the primary windings of the transformer T_3 are oppositely directed there will be a resultant carrier current transmitted to the secondary winding of the transformer T_3 which will be proportional to the difference between the currents flowing in the output circuits of the tubes M_1 and M_2, respectively. The output circuit O will therefore receive current of the carrier frequency modulated by the low frequency signals.

The neon tube N operates very rapidly so that a change from the condition in which carrier current is to be transmitted to the condition in which carrier current is to be suppressed takes place practically instantly. Furthermore, no change occurs in the structure of the neon tube N such as will interfere with its operating characteristics.

Fig. 2 shows a curve characteristic of the tubes M_1 and M_2, in which grid voltage is plotted as abscissas against plate current as ordinates. The point *a* on this characteristic curve has an ordinate which corresponds to the average plate current in both tubes M_1 and M_2 when no low frequency signals are being transmitted to the grids of these tubes. In a perfectly balanced system the current in the plate circuit of one of the tubes will be equal to the current in the plate circuit of the other of the tubes.

When the low frequency signals are being transmitted to the grids of these respective tubes, it has been shown hereinabove that the neon tube N associated with the tube M_1 shunts the grid and filament of the tube M_1 so that the potential of the grid with respect to the filament of the tube M_1 will no longer be equal to the potential of the grid with respect to the filament of the tube M_2. The grid of the tube M_1 will be less negatively biased with respect to its filament than it previously was. The point *b* of the characteristic curve represents the point at which the tube M_1 then operates. This point *b* is less negative than the point *a*, and therefore the plate current in the tube M_1 is greater than the plate current in the tube M_2. The lines drawn from the points *a* and *b* to the axis of abscissas correspond, respectively, to the plate currents in the tubes M_1 and M_2. Consequently, the current in the secondary winding of the transformer T_3 receives a carrier current having an amplitude proportional to the difference between these two lines.

It will be understood that by changing the magnitude of the potential of the battery B_2, the magnitude of the resistance R_1, or the break-down potential of the neon tube N, the amplitude of the carrier current flowing in the output circuit O may be suitably controlled.

It will be understood also that while a neon tube has been shown and described herein for the purpose of illustration, any other device which has a high impedance when the potential applied thereto is below a predetermined value and a moderate impedance when the potential applied thereto equals, or is greater than, the predetermined value, may be employed instead thereof within the scope of the appended claims.

While the arrangements of this invention have been shown and described in one particular embodiment merely for the purpose of illustration, it is to be understood that the invention is capable of embodiment in other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The method of signaling which consists in generating a high frequency wave, generating low frequency signals, modulating the high frequency wave by the low frequency signals, and substantially suppressing the high frequency wave when the magnitude of the low frequency signals drops below a predetermined value and freely transmitting the high frequency wave modulated by the low frequency signals when the magnitude of the low frequency signals rises beyond the predetermined value.

2. The method of signaling which consists in generating a high frequency wave, generating low frequency signals, modulating the high frequency wave by the low frequency signals, transmitting the modulated high frequency wave when the magnitude of the low frequency signals is above a predetermined level, and substantially suppressing the high frequency wave so that it remains untransmitted when the magnitude of the low frequency signals is below said predetermined level.

3. The method of signaling which consists in generating an alternating current wave of one frequency, generating low frequency signals, superimposing said low frequency signals on said alternating current wave, and substantially suppressing the alternating current wave when low frequency signals are being generated below a predetermined level and freely transmitting the alternating current wave modulated by the low frequency signals when the low frequency signals are being generated above said predetermined level.

4. The method of signaling which consists in generating a wave of one frequency, generating a wave of a second frequency, superimposing the wave of the second frequency on the wave of the first frequency, and substantially suppressing the wave of the first frequency when the wave of the second frequency is being generated at a level below a predetermined value and freely transmitting the wave of the first frequency modulated by the wave of the second frequency when the wave of the second frequency is being generated at a level above the predetermined value.

5. A system for signaling comprising a high frequency wave, a source of low frequency signals, means for modulating the high frequency wave by the low frequency signals, when the magnitude of the low frequency signals rises above a predetermined value, and means for substantially suppressing the high frequency wave when the magnitude of the low frequency signals drops below said predetermined value.

6. A signaling system comprising a generator of a high frequency wave, a source of low frequency signals, means for modulating the high frequency wave by the low frequency signals, means for transmitting the high frequency wave modulated by the low frequency signals when the energy level of the low frequency signals is above a predetermined value, and means for substantially suppressing the high frequency wave so that it remains unmodulated and untransmitted when the energy level of the low frequency signals is below the predetermined value.

7. A signaling system comprising a generator of an alternating current wave, a generator of low frequency signals, means for superimposing the low frequency signals on the alternating current wave, and means for substantially suppressing the energy of the alternating current wave when the energy of the low frequency signals drops below a predetermined level and for freely transmitting the energy of the alternating current wave with the superimposed low frequency signals when the energy of the low frequency signals rises above the predetermined level.

8. A signaling system comprising a generator of current of one frequency, a generator of current of a second frequency, means for superimposing the wave of the second frequency on the wave of the first frequency, and means for substantially suppressing the wave of the first frequency when the wave of the second frequency is being generated at a level below a predetermined value and for freely transmitting the wave of the first frequency modulated by the wave of the second frequency when the wave of the second frequency is being generated at a level above the predetermined value.

9. In a translating system, a pair of translating devices having input and output circuits, a circuit for the reception of signal waves, another circuit containing a source of energy of a carrier wave, one of said circuits being symmetrically associated with said input circuits and the other being oppositely associated with said input circuits, a receiv-

ing circuit differentially associated with said output circuits, and means for substantially preventing the flow of energy of the carrier wave to the receiving circuit when the level of the energy of the signal waves is below a predetermined value and for freely permitting the flow of energy of the carrier wave modulated by energy of the signal waves to the receiving circuit when the level of the energy of the signal waves is above the predetermined value.

10. In a translating system, a pair of translating devices having input and output circuits, a circuit for the reception of signal waves, another circuit containing a source of energy of a carrier wave, one of said circuits being symmetrically associated with said input circuits and the other of said circuits being oppositely associated with said input circuits, a receiving circuit differentally associated with said output circuits, and a discharge device associated with the input circuit of one of the translating devices, said discharge device undergoing a substantial drop in impedance when the level of the signal energy is above a predetermined value.

11. A modulating system comprising a pair of translating devices, a source of high frequency energy symmetrically connected with said devices, a source of modulating energy oppositely connected with said devices, an output circuit differentially connected with said devices, and means consisting of a discharge device connected to one of the translating devices for substantially unbalancing the translating devices when the modulating energy is normal, whereupon the output circuit will receive high frequency energy superimposed by modulating energy.

12. A modulating system comprising a pair of translating devices, a source of high frequency energy symmetrically connected with said devices, a source of modulating energy oppositely connected with said devices, an outgoing circuit differentially connected with said devices, and means consisting of a discharge device connected to one of the translating devices for substantially increasing the flow of current in one of said translating devices beyond that occurring in the other of said translating devices, whereupon the outgoing circuit will receive high frequency energy superimposed by modulating energy.

13. A modulating system comprising a pair of translating devices, a source of high frequency energy symmetrically connected with said translating devices, a source of modulating energy oppositely connected with said translating devices, an outgoing circuit differentially connected with said translating devices, and a discharge device connected to one of said translating devices which will be ineffective until the modulating energy rises beyond a predetermined value, whereupon the flow of current in the translating device to which the discharge device is connected will substantially exceed the flow of current in the other translating device.

In testimony whereof, I have signed my name to this specification this 10th day of July 1926.

RICHARD K. HONAMAN.