

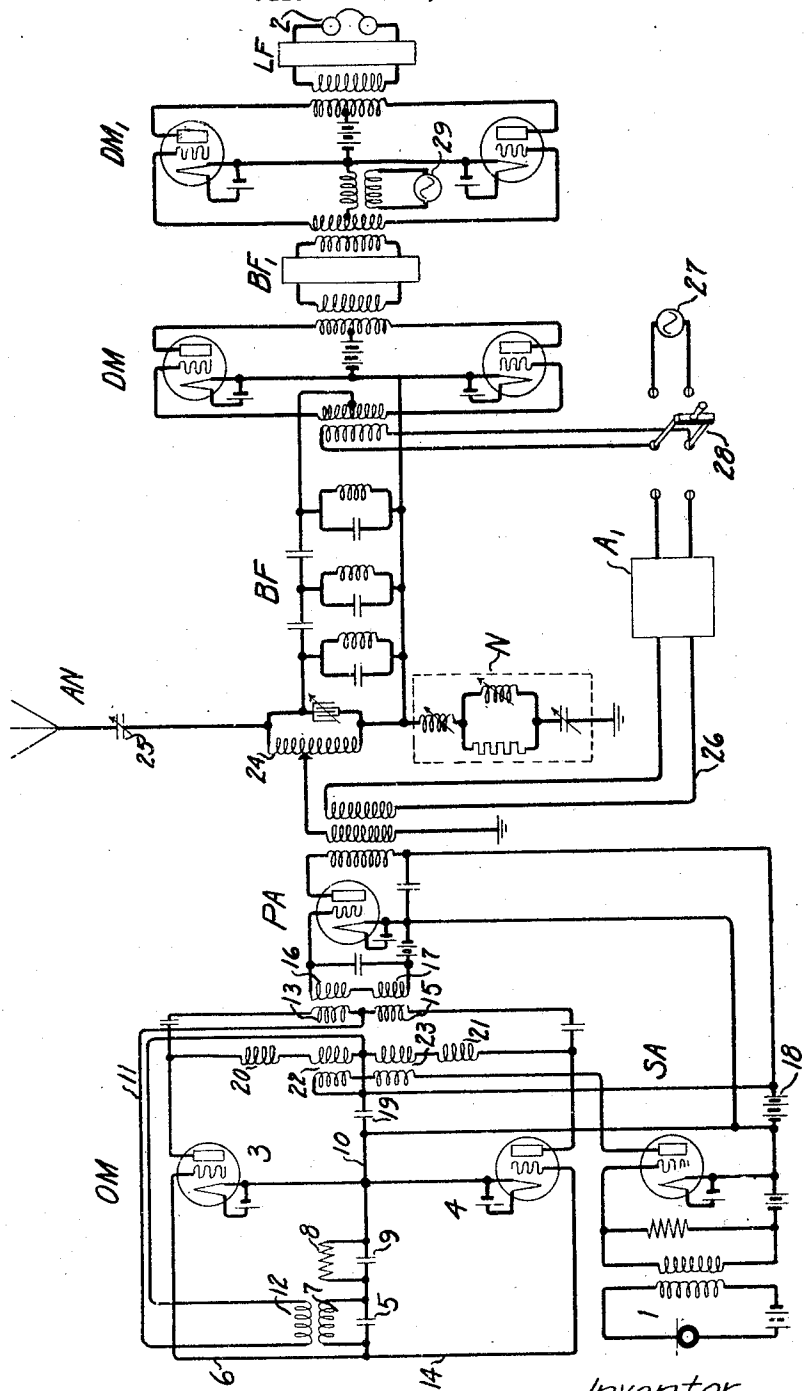
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J. F. FARRINGTON

SIGNALING SYSTEM

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Inventor
John F. Farrington
by *E. W. Adams* Atty.

UNITED STATES PATENT OFFICE.

JOHN F. FARRINGTON, OF FLUSHING, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

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This invention relates to signaling systems and, as illustrated in the embodiment herein described, is particularly adapted for use in radio telephone systems.

5 An object of the invention is to provide improved methods of and means for two-way high frequency, particularly radio, signaling, whereby reception may be accomplished efficiently and without harmful interference
10 either from waves simultaneously transmitted from the outgoing transmission channel of the same two way system, from incoming or outgoing transmission of other two-way systems that might be combined with it
15 to constitute a multiplex system, or from other transmissions not related to the system under consideration simultaneously traversing the same transferring medium, for example, the ether.

20 In a well-known type of carrier wave signal system disclosed, for example, in French Patent 24,792, patented June 26, 1922, constituting the first addition of Patent 541,217, oppositely directed transmissions of a two way
25 signaling channel utilize continuously transmitted carrier waves differing in frequency by an amount above that used for modulation in either direction. Provision is made whereby the receiver at each station receives a carrier wave from its own transmitter, as well as
30 from the distant station. These two different frequency waves, either or both of which may be modulated, are combined at either station to produce another carrier wave called
35 the "auxiliary carrier wave", which is modulated in accordance with the modulations of the carrier waves concerned in its production. This modulated auxiliary carrier wave is detected to produce the signal, or signals. This
40 type of system has the beneficial attributes of the well-known heterodyne system, which it in many respects resembles, namely, it provides an efficient means for signal amplification (either in the first detector itself or in
45 separate auxiliary frequency amplifiers). It has the further unique advantage that the side tone interference from the transmission may be strictly limited. For example, if the same percentage of modulation is used for
50 both systems of transmission, the reproduced normally received signals and the interfering side tone signals have equal intensities regardless of the relative quantities of energy associated with their respective carrier currents.
55 Accordingly, an adjustment to produce a de-

sired amplitude of incoming signal (which is possible of attainment for widely different conditions of interlinkage of the transmitting and receiving circuits) insures that the side tone will be within permissible limits. The
60 practical necessity on ship board and in similarly restricted areas of using closely contiguous transmitting and receiving antennæ, or a common antenna, where excessive side tone would otherwise negative the efficient
65 use of the circuits, has, for the above reason, favored the use of this type of two way system in such places.

In another equally well-known type of system, not necessarily limited to two way operation, the production of the signal modulated carrier wave is accompanied, or followed, by suppression of the unmodulated carrier with attendant advantages, among others, of
70 energy conservation and comparative secrecy.

The practical embodiment of such a carrier suppression system in a two way system of the type described above, presents difficulties, since the product of the first stage of detection therein would not include a wave of the un-
80 modulated auxiliary carrier frequency, which is necessary for the reproduction of the signal in the subsequent stage of detection.

It is a further object of this invention to provide improved means for overcoming that
85 difficulty, that is, to provide a two-way system having all of the important features of the two-way system described, and which has the additional advantages inherent in any system operating on the suppressed carrier principle.

90 In the system, according to one mode of operation, a minute amount of the unmodulated carrier is transmitted. This amount is insignificant so far as it affects the amount of energy concerned in transmission. It is in-
95 sufficient to permit the reproduction of the signal by simple detection. It is insufficient even for signal reproduction by double detection in accordance with conventional methods of operating two-way systems of the general
100 type described. In the method of receiving such a wave practiced by this invention, energy from the transmitting circuit at the same station, amplified if necessary, is im-
105 pressed on the first detector through a separate conductive connection. The invention, as to this feature, differs from that of applicant's U. S. Patent 1,495,470, May 27, 1924, in that the circuit for conducting this energy is tapped into the transmitting circuit at a
110

point between the modulator and the antenna, so that the signal side tone is heard in the receivers, as in the more conventional forms of two way systems of this general type.

Partial suppression even though not sufficient to prevent detection by simple means is useful in proportion as its effects economy in transmission.

Another feature of the invention is the use of a band pass filter between the antenna and the first detector. This feature is applicable to any two-way system of the general type described, whether or not the unmodulated carrier is suppressed and without regard to the particular means for obtaining the reinforcing wave at the input of the first detector. It functions, in any form of such system, to give greater security from "pulses", or similar phenomena originating in the transmission circuit or elsewhere, than can be secured by the use of resonant circuits. Its highly selective qualities enable it to discriminate from undesired carrier waves which are incident on the antenna. It is also useful in a system where it would otherwise be difficult to limit the amount of energy transmitted from the antenna to the receiving circuit to a sufficiently small amount for efficient reception by the auxiliary frequency method.

A feature of the invention which may, in special cases, be used with or without the co-operation of the filter to completely prevent, or to regulate, the flow of current from the transmitting to the receiving circuit, where a common antenna is used, is the connection of the transmitting circuit to the antenna in balanced relation with respect to the points to which the receiving circuit is connected.

Complete, instead of a partial suppression of the unmodulated carrier may be used at both stations, if separate local sources are used with each stage of demodulation. If the distant station transmits some unmodulated carrier, of course the product of the first demodulated operation would contain an unmodulated auxiliary carrier wave, so that in this case, a local source, otherwise used with the second stage of demodulation, would be unnecessary.

The invention includes a novel means for producing a modulated wave characterized by complete or any desired degree of partial suppression of the unmodulated carrier component. Two carrier wave oscillators are coupled together in balanced relation so as normally to produce no output wave. The modulating wave is differentially impressed upon the space current paths of the balanced oscillators to proportionally unbalance the circuit, as in the quite similar balanced modulator circuit.

A particular advantage in the use of suppressed carrier transmission inheres in the operation of two-way circuits on board ship

or in other confined spaces in that the transmitting power is not impressed on the antenna during the non-signaling intervals. This prevents the production of noises in the receiver telephones, during the listening periods, due to the production of transient oscillations resulting from sparking between the various parts of the rigging and other metal work brought in momentary imperfect contact by the swaying and vibration of the ship or by high winds, which parts are in the field of the transmitting antenna or within the influence of the high power of the transmitter.

The effect on the receiver output of transient oscillations produced by sparking during the transmitting intervals when power is on the antenna may be reduced by the use of an efficient high frequency filter (in the position BF of the diagram) designed to reduce the potentials impressed on the input of the receiving set from the transmitter of the same station to the desired minimum consistent with its function of transmitting the carrier frequencies from the transmitters of both stations to the high frequency detector where they are inter-modulated to produce the auxiliary carrier wave.

Further objects and features will be apparent to those skilled in the art from a reading of the following detailed description with reference to the accompanying drawing which represents a station of a two way system having the features of, and capable of operation according to, the invention.

In the drawing a common antenna AN is used both for transmitting and receiving.

The elements 1, SA, OM and PA at the left of the antenna are respectively, a signal frequency source, a signal current amplifier, an oscillator-modulator and a power amplifier. They cooperate to produce a signal modulated wave having all or any desired part of its unmodulated carrier wave suppressed. Through the medium of suitable filters in the input of amplifier PA, either side band of the modulated wave may be suppressed if desired. For convenience, the system will be assumed to be used for speech signaling.

The elements, BF, DM, BF₁, DM₁, LF and 2, at the right of the antenna are respectively, a high frequency band pass filter, a high frequency demodulator, an auxiliary frequency band pass filter, an auxiliary frequency demodulator, a low pass filter and an indicator. They cooperate with each other and with the transmitting circuit in the manner to be described to receive speech modulated waves transmitted from a distant station and to reproduce therefrom a modulating component. The carrier frequencies for transmission and reception differ by an amount above audibility.

Depending upon the particular adjustments of the several elements, and in some instances, on the choice of elements used,

the system as a whole and its contained elements are capable of widely different functions. The elements will first be described without special reference to their respective possible functions in the system as a whole and this will be followed by a description of the operation of the system.

The oscillator-modulator OM is similar to oscillator-modulators generally in that it includes means whereby the current from the signal frequency source 1, after amplification in signal or speech amplifier SA, is employed to vary the condition of oscillation of a carrier wave oscillator to the extent that its variations are impressed on the resultant high frequency current of the oscillator.

It differs from conventional oscillator-modulator circuits in that the oscillator when not subjected to signal modulation, delivers no carrier wave to its output circuit. Electrical discharge devices 3 and 4 with their associated circuits each constitute a feed back oscillator of the well-known tuned input type. The input circuit of oscillator 3 is constituted by circuit 5, 6 containing the frequency determining resonant circuit 7, the grid leak resistance 8 and the grid condenser 9. The input circuit is coupled with the output circuit, which includes conductor 10, conductor 11, coupling coil 12, and transformer primary 13. The circuit of oscillator 4 is similar and includes in common therewith the elements 5 and 7 to 12 inclusive. The input and output circuits are completed through paths distinct from those used by oscillator 3 including respectively, conductor 14 and transformer primary 15. Since the oscillators have a common frequency determining circuit they oscillate at the same frequency. However, the transformer primaries 13 and 15 are wound in the same direction, considered as portions of a single winding, and are traversed by currents in respectively opposite directions, so that if the output currents are in the same phase within the common portion of their circuits, and of equal value, their effects in the secondaries 16 and 17 are balanced, assuming that the individual transformer constituted respectively by windings 13, 16 and 15, 17 have equal ratios of turns. The desired balanced relation of the currents in secondaries 16 and 17 is insured by the arrangement of the respective input circuits whereby the input energy is impressed from coupling coil 12 and translated to the respective input elements in the same phase. The relation of input and output currents is perpetuated by constituting coupling coil 12, a portion of a circuit which is common to the two output circuits.

Space current for the two oscillator tubes is supplied by source 18, which also supplies the space current for amplifier SA, through circuits 20 and 21 respectively. Condenser 19 by-passes the generated high frequency

currents around this battery. By preliminary adjustment the output circuits may be made balanced or not, as desired. If balanced, the oscillator normally produces no carrier wave in the output circuit 16, 17; if unbalanced, a wave whose amplitude is proportional to the degree of unbalance. If the space current circuit of one of the oscillator units is interrupted the other units function in a conventional manner as a single tube oscillator.

Modulating currents are impressed from amplifier SA on the space current paths of the modulator tubes by means of transformers 22 and 23. The current flows through the primaries of the transformers in the same direction relative to circuits 20 and 21 and accordingly differentially affects the potentials of the plates of the two tubes. Accordingly, if the circuits are initially adjusted to give a perfect balance of generated currents, modulation results in an unbalance proportional to the impressed modulating current and consequently, the production of a resultant wave whose amplitude and frequency vary in accordance with the modulating current. The output accordingly includes signal modulated side bands without any unmodulated carrier.

The modulation product is amplified by power amplifier PA and impressed on antenna AN.

Elements in the transmitting system which have not been specifically mentioned are well-known in the art and need no description. Modulation by the method of impressing modulating potentials on the plate of a modulator tube is old, and is disclosed, for example, in British Patent 15,237 of 1915.

The transmitted energy is impressed on the antenna circuit between ground and a point between the ends of inductance 24. The energy accordingly flows between these two points in parallel paths, one of which includes the aerial and its capacity to ground and the other the artificial network N which is designed to simulate the electrical characteristics of the first path. Accordingly, with a particular critical positioning of the intermediate point a balance can be effected for the potentials across the inductance, across which the receiving circuit is connected, so that transmission does not result in an interfering current in the receiver. Condenser 25 may be adjusted so that the antenna system as thus constituted is tuned to the transmitted wave.

By a slight adjustment of the point away from the balancing position a predetermined amount of reinforcing energy from the local transmitter may be permitted to flow to the receiving circuits.

Filter BF may be of any type capable of passing with negligible attenuation currents in a definite band of frequencies, such as one

or more incoming carrier side bands with or without some unmodulated carrier, and to substantially completely attenuate currents of all other frequencies. The type illustrated is disclosed in U. S. patent to Campbell 1,227,113, granted May 22, 1917. Depending upon the degree of perfection of the balance, or the degree of perfection of the filter in excluding currents of frequencies outside of its normal band, or upon both of these means, all or any desired amount of the energy from the transmitter may be excluded from the receiving circuit.

The signal modulated wave from the distant station which is passed through the filter together with carrier energy transmitted through the filter from the transmitting circuit or, in the alternative, transmitted therefrom through auxiliary circuit 26 including amplifier A, if necessary, or from a separate local source 27, is impressed on the high frequency demodulator DM. If both of the last two mentioned sources of carrier frequencies are provided, a proper choice therebetween then may be made by switch 28.

Demodulator DM is of the balanced type which is completely disclosed in U. S. patent to Carson 1,343,306, granted June 15, 1920. Any other type of demodulator using one or more tubes may equally well be used. It is characteristic of the balanced type that, if critically adjusted, the demodulated output contains no component having any of the frequencies of the currents impressed on the common path of the divided input circuits or any component resulting from the combination of these currents. Accordingly, if the reinforcing current is transmitted through the filter, the demodulator circuit must be unbalanced or the circuit of one tube made inoperative so as to effectively constitute the circuit a single tube demodulator.

The resultant auxiliary carrier frequency, together with the side bands, are selected by band pass filter BF₁, which may be similar to band pass filter BF, and combined in auxiliary frequency demodulator DM₁. This demodulator instead of being of the balanced type illustrated may be of any conventional type. If the incoming high frequency wave does not include an unmodulated carrier component, so that the high frequency demodulator does not yield an unmodulated auxiliary carrier wave, this wave may be supplied by local source 29.

The resultant signal component is selected and transmitted through low pass filter LF and indicated in telephone receiver 2.

The system may be operated in accordance with various modes as follows:

Sparking between metallic parts of a ship subjected to the influence of the strong outgoing power would result in transient oscillations being produced by an otherwise unmodulated transmitted carrier. The effect of

these extraneous disturbances may be totally prevented from affecting the receiver by critical adjustment of the oscillator-modulator to completely suppress the carrier. For this case, that is when there is no outgoing energy to create a field which would tend to result in spark modulation, the filter BF is useful in protecting the receiving circuit from other interference effects, but might be replaced by a less selective means. Reinforcing current for the receiver is supplied from local source 27 which must produce a frequency which differs from the incoming carrier frequencies by an inaudible amount, but does not have to have a frequency identical with the outgoing carrier frequency. A second local source 29 is used if the current is suppressed at the distant station.

If the carrier is not suppressed the effect in the receiver of noise modulation of the carrier can be reduced by means of the filter BF. Reinforcing current can be supplied by the local source 27. The choice as to the use of the second local source is the same as for the first mentioned case.

The balanced connection of the transmitter to the antenna, with or without the filter, may be relied on to prevent disturbances originating in the transmitting circuit from affecting the receiving circuit, a separate local source of reinforcing waves being used. This arrangement can similarly be used whenever it is desired to prevent the transmitted carrier currents, or this current modulated, from entering the receiving circuit. The modulator-oscillator may be adjusted to give an insufficient unmodulated carrier to yield a signal by simple demodulation. However, reception by the auxiliary frequency demodulation method provides an auxiliary frequency carrier which may be separated from its side bands, amplified, and combined therewith in the second demodulator as disclosed in applicant's U. S. Patent 1,495,470, May 27, 1924. Alternatively, sufficient auxiliary current may be obtained by using the auxiliary circuit 26 and amplifier A₁. Circuit 26 is connected to the transmitting circuit in such manner as to impress a side tone on the receiving circuit during signal transmission from the same station. A local source 27 can be used alternatively with circuit 26, as above explained, or the auxiliary circuit can be connected directly to either oscillator 3 or 4, as in the similar arrangement described in U. S. Patent 1,495,470, May 27, 1924, above mentioned.

Obviously the auxiliary circuit 26 or the local source (or sources) could be effectively used even if the unmodulated carrier is transmitted. For example, conditions might require such a degree of selection by filter BF as to prevent the transmission of sufficient reinforcing current therethrough. On the other hand, reinforcing current may be sup-

plied from the transmitting circuit to the receiving circuit through the antenna by respectively unbalancing the connection a predetermined small amount or by using a filter
 5 which will transmit a sufficient quantity of current of the transmitted carrier wave frequency. Use of the balanced connection in a similar circuit is disclosed in Fig. 5 of French Patent 24,792, patented June 26, 1922,
 10 constituting the first addition of Patent 541,217.

What is claimed is:

1. In a radio system comprising a station having an incoming wave receiving circuit
 15 including a broad band filter selective to the frequencies of the incoming wave, a source of high frequency carrier waves for transmitting outgoing signals, means for combining waves from said source with incoming
 20 waves whereby waves of an inaudible frequency different from that of either of said frequencies are produced, and means for deriving audible incoming signals from said last mentioned wave.

25 2. A radio station comprising means for producing a signal modulated carrier wave, common means for radiating said wave and for receiving a signal modulated carrier wave whose frequency differs by an inaudible
 30 amount from that of said first mentioned carrier wave, means for deriving signals from said received wave, a band pass filter selective at the frequency of the received wave between said common means and said signal deriving
 35 means, said signal deriving means comprising means for combining energy of the outgoing wave with energy of the incoming wave to produce an inaudible frequency signal modulated auxiliary carrier wave, and means
 40 for deriving incoming signals from said auxiliary carrier wave.

3. A radio station comprising means for producing a signal modulated carrier wave, means for radiating said wave and for
 45 receiving a signal modulated carrier wave whose frequency differs by an inaudible amount from that of said radiated wave, means for deriving signals from said received wave, a band pass filter selective to the received wave between said receiving means
 50 and said deriving means, said deriving means comprising means for combining energy of the outgoing and incoming waves to produce an inaudible frequency signal modulated auxiliary carrier wave, and means for deriving
 55 incoming signals from said auxiliary carrier wave.

4. The method of signaling between two stations which comprises generating at each
 60 station a carrier wave, at intervals modulating said carrier wave in accordance with signals, continuously transmitting said carrier waves modulated at intervals, radiating at least a portion of the transmitted wave at
 65 each station, receiving a wave incident on at

least one station from the other station, receiving a portion of the transmitting wave at the local station independently of the radiation and of the first mentioned receiving step combining said received waves to pro-
 70 duce an auxiliary carrier wave modulated at intervals in accordance with the signal modulations at both stations, and reproducing a signal from said auxiliary carrier wave.

5. The method of secret signaling between
 75 two stations which comprises continuously transmitting carrier waves from each station, at least part of the time transmitting from each station signal modulated side
 80 bands of said waves, the unmodulated carrier component transmitted from at least one station being too small to reproduce a sufficiently perfect signal by single detection, selectively receiving the waves incoming on
 85 each station, combining the received modulated small-amplitude carrier waves with a wave derived from the signal modulated wave at the same station to produce an auxiliary carrier wave modulated by the signal
 90 at both stations, and reproducing the signals from said auxiliary carrier wave.

6. A station of a signaling system comprising a generator of carrier frequency waves, means for modulating said waves in accordance with signals, means for radiating said
 95 modulated waves and for receiving incoming waves, a demodulator, a non-signaling circuit between the output circuit of said modulator and said demodulator, means for selecting a signal modulated combination component
 100 from the demodulator product, and means for reproducing the signals from said modulated combination component.

7. A station of a signaling system comprising a source of carrier frequency waves,
 105 means for modulating said waves in accordance with signals, a common means for radiating said modulated waves and for receiving modulated incoming waves, a demodulator, a band pass filter between said
 110 common means and said demodulator sharply selective to the incoming waves, a non-signaling circuit between the output circuit of said modulator and said demodulator, means for selecting a signal modulated combination component from the demodulator product, and means for reproducing the signals from said modulated combination product.

8. In a station for communication systems, a grounded antenna comprising a radiating
 120 member an impedance member and an artificial network, a transmission circuit connected between two points in said antenna, one point being between the ends of said impedance, a receiving circuit associated with
 125 said antenna in such a manner as to derive its potentials from points therein in respectively opposite directions from said intermediate point, the positioning of said intermediate and receiving circuit points and the
 130

impedance of the balancing network together being such that a minimum of energy from the transmitting circuit is impressed on said receiving circuit, a local source having a frequency differing by an inaudible amount from that of the received waves, means for combining the received waves with waves from said source to produce a modulated auxiliary carrier wave, and means to reproduce a signal from said auxiliary carrier wave.

9. A system for generating a modulated carrier wave having substantially no unmodulated carrier component comprising a pair of electric discharge devices each including a filament, an anode and a control electrode, input circuits respectively connected to the filaments and control electrodes of said device and including a common portion, a tuned circuit in said portion, output circuits respectively connected to the filaments and

anodes of said devices and each including a common portion and an individual portion, a feed back circuit in the common portion of the output circuit coupled with said tuned circuit, a coupling coil in each of said individual portions, an outgoing circuit including a winding coupled with said coupling coils, the magnetic circuits of said coupling coils and winding being so arranged, and the constants of the remaining parts of the system being so determined that in the normally oscillating condition of the system there is a resultant difference of potential across said winding corresponding to a desired degree of unbalance, and means for impressing modulating currents on the anodes of said devices in relatively opposite phases.

In witness whereof, I hereunto subscribe my name this 4th day of March, A. D. 1924.

JOHN F. FARRINGTON.