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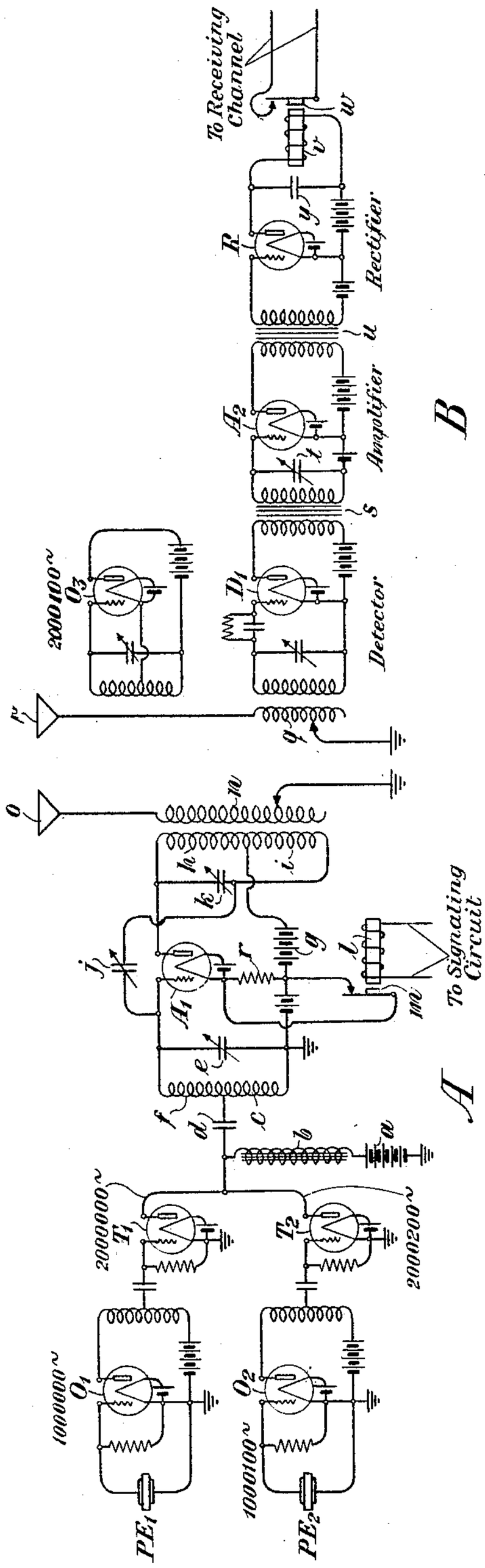

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RADIO SIGNALING SYSTEM

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This invention relates to radio signaling systems, and more particularly to systems wherein two or more high frequencies are transmitted upon which the same signals are simultaneously superimposed.

It has been the practice heretofore to transmit signals between two stations a considerable distance apart by means of a single high frequency wave, the signals being superimposed thereupon. But in such systems the signals very ofted faded away on account of the effect of the condition of the atmosphere thereon. It has been due to this fading effect that signals were sometimes completely lost during short periods, causing mistakes in the record during those periods.

It is therefore an object of this invention to provide a system in which two or more high frequencies are employed, the signals being simultaneously superimposed on all of said high frequencies, so that when one of the high frequencies upon which signals are superimposed fades away another high frequency upon which the signals are superimposed will be transmitted to the distant station unaffected by atmospheric conditions. The method and means by which this object is accomplished constitute one of the novel features of this invention.

Other objects and features of this invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention suitable as a radio telegraph system.

Referring to the drawing, two stations A and B are shown. At station A there are two high frequency oscillation generators O_1 and O_2 which are controlled as to frequency by piezo-electric devices PE_1 and PE_2. These piezo-electric devices PE_1 and PE_2 render the oscillations of the high frequency oscillation generators O_1 and O_2 constant within narrow limits. The frequency of these oscillation generators O_1 and O_2 may be, for example 1,000,000 and 1,000,100 cycles. The output circuits of these oscillation generators are respectively connected to the input circuits of three-electrode vacuum tubes T_1 and T_2. A source of potential a supplies the necessary space current to the anodes of vacuum tubes T_1 and T_2 through an alternating current choke coil b. The output circuits of the vacuum tubes T_1 and T_2 for alternating currents include the inductance c and the condenser d (said inductance and condenser being in common to said circuits) and the anode and cathode of the respective vacuum tubes T_1 and T_2. The variable condenser e is employed for tuning the output circuits of these vacuum tubes T_1 and T_2 to any frequencies, preferably harmonics of the frequencies in the input circuits of these tubes, for example, 2,000,000 and 2,000,200 cycles, respectively.

The input circuit of an amplifier A_1 is coupled by means of inductances f and c to the output circuits of the vacuum tubes T_1 and T_2. Because of this coupling, the same frequencies are impressed on the input circuit of the amplifier A_1 as are present in the output circuits of vacuum tubes T_1 and T_2. The source of potential g supplies the necessary space current to the anode of the amplifier A_1 in the circuit including the inductance h, the anode and cathode of the amplifier A_1 and the source of potential g. The variable condenser j and the inductance i are connected across the anode and grid control electrode of the amplifier A_1 in order to neutralize the electrostatic capacity existing between said electrodes. The variable condenser k is employed for tuning the output circuit of the amplifier A_1 to any frequencies, for example, 2,000,000 and 2,000,200 cycles, the tuning of this output circuit being broad enough to include both frequencies.

A heavy resistance r is connected to the input and output circuits of the amplifier A_1, in common to said circuits. A relay having a winding l and an armature m is employed for superimposing signals on the high frequencies present in the input circuit of the amplifier A_1. The winding l of this relay may be connected to a source of potential and a telegraph key, or any other means for making and breaking the current flowing in the winding l. When current flows through the winding l, the armature m will be attracted and will close its contact to shunt the resistance r. Thus the two high frequencies in the in-

put circuit of the amplifier A_1 will be amplified by the amplifier A_1 and will appear in the output circuit thereof. When no current flows through the winding *l*, the armature *m* will be released opening its contact and permitting the resistance *r* to be connected in common in the input circuit and in the output circuit of the amplifier A_1. Thus the grid control electrode of the amplifier A_1 will be made highly negative with respect to the cathode and will prevent the high frequencies present in the input circuit of the amplifier A_1 from being amplified thereby. Signals that cause the winding *l* to become energized and deenergized permit the high frequencies to be alternately transmitted and then suppressed by the amplifier A_1. The inductance *n* is loosely coupled to the inductances *h* and *i* in order to permit the high frequencies in the output circuit of the amplifier A_1 upon which signals are superimposed to be transmitted to the antenna *o*.

At station B an antenna *p* and an inductance *q* are tuned so as to receive the high frequencies modulated in accordance with signals transmitted by the antenna *o* at station A. These high frequencies are then impressed on the input circuit of the detector D_1. Another oscillation generator O_3 is coupled to the input circuit of the detector D_1 in order to provide a frequency which is to beat with the received high frequencies in the input circuit of the detector D_1. This oscillation generator O_3 may be an oscillation generator of any well known type, preferably a vacuum tube oscillation generator suitable for transmitting oscillations at very high frequency. For the sake of simplicity this oscillation generator O_3 will have oscillations of a frequency, of, for example, 2,000,100 cycles, half way between the high frequencies transmitted by station A upon which signals are superimposed.

All of these frequencies beat in the input circuit of the detector D_1 to produce in the output circuit of the detector D_1, among other frequencies, the difference frequency of 100 cycles. The transformer *s* transmits frequencies in the output circuit of the detector D_1 to the input circuit of an amplifier A_2. This amplifier has a variable condenser *t* associated with the input circuit thereof in order to permit only the difference frequency of 100 cycles to be transmitted thereby to the exclusion of the higher frequencies. This low frequency is amplified by the amplifier A_2 and appears in amplified form in the output circuit thereof. Another transformer *u* is employed for impressing this amplified low frequency on the input circuit of a vacuum tube rectifier R. The rectified current energizes the winding of a relay *v*, the armature of which is *w*, so as to transmit the signals represented by the rectified current to the channel operated by the armature *w*. A condenser *y* is connected in the output circuit of the vacuum tube rectifier R to form a path of low impedance for any alternating current that may appear in the output circuit of said rectifier.

The arrangements of this invention operate in the following manner for the transmission of signals from station A to station B.

Two high frequencies, for example, 1,000,000 and 1,000,100 cycles, are set up by the oscillators O_1 and O_2, respectively, these high frequencies being controlled as to frequency by the piezo-electric devices PE_1 and PE_2. These high frequencies are impressed on the input circuits of the vacuum tubes T_1 and T_2, the output circuits of these vacuum tubes being tuned to harmonics of the frequencies in the input circuits of these tubes, for example, 2,000,000 and 2,000,200 cycles, respectively. These two high frequencies are then impressed on the input circuit of the amplifier A_1. Signals are also transmitted to the input circuit of the amplifier A_1 by means of the winding *l* and the armature *m* of a relay connected to a signaling circuit. These signals are simultaneously superimposed on both high frequencies, and these high frequencies upon which the signals are thus superimposed appear in the output circuit of the amplifier A_1. Thereafter they are transmitted to the antenna *o* for transmission to station B.

The antenna *p* at station B is tuned to receive the high frequencies upon which signals are superimposed which are transmitted by the apparatus at station A. These frequencies are then impressed on the input circuit of the detector D_1. There are also impressed on the input circuit of the detector D_1 the oscillations of an oscillation generator O_3, which has a frequency of, for example, 2,000,100 cycles, half way between the frequencies upon which the same signals are simultaneously superimposed at station A. These three high frequencies beat in the input circuit of the detector D_1 to produce a difference frequency of 100 cycles in the output circuit thereof. This low frequency is amplified by the amplifier A_2, and the other higher frequencies are eliminated. After amplification by the amplifier A_2 the low frequency is transmitted to the rectifier R which has the winding *v* of a relay connected in the output circuit thereof. This winding *v* becomes energized in accordance with rectified signals, so that the signals may be impressed on a channel operated by the armature *w* of this relay.

The frequencies used herein are merely for purpose of illustration, and in practice other frequencies may be employed as conditions necessitate.

While the arrangements of this invention have been disclosed with particular reference to a radio telegraph system, it is to be under-

stood that it is capable of embodiment in a radio telephone system, among other systems, for the transmission of voice frequencies, the frequencies employed for transmission upon which voice frequencies are to be superimposed differing from each other by a frequency above the limits of audition.

It will be understood that while only two frequencies have been employed for transmission upon which signals are simultaneously superimposed, the invention is not so limited, but any number of high frequencies may be employed, the signals being simultaneously superimposed on all of said frequencies.

While this invention is disclosed in one particular embodiment which is deemed desirable, it is to be understood that it 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 interrupting two sinusoidal currents of high frequencies simultaneously in accordance with signals, amplifying said interrupted high frequencies, beating with said interrupted high frequencies sinusoidal current of another high frequency midway between said two high frequencies so as to obtain a low frequency current interrupted in accordance with said signals, amplifying said low frequency current thus interrupted, and rectifying said interrupted low frequency current so as to obtain the signals therefrom.

2. In a radio signaling system, in combination, means for generating two sinusoidal currents of different high frequencies, means for simultaneously interrupting and thereby modulating said high frequencies in accordance with telegraphic signals, means for generating sinusoidal current of a third high frequency midway between said two high frequencies which are interrupted and which is to be beaten with said high frequencies, means for beating all of said high frequencies together so as to obtain a low frequency current interrupted and modulated in accordance with said signals, and means for deriving the signals from said low frequency current.

3. The method of signaling which consists in beating a pair of sinusoidal currents of high frequencies both modulated in accordance with the same signals with sinusoidal current of another high frequency midway between said pair of high frequencies so as to obtain current of a low frequency, said low frequency being modulated in accordance with said signals, and deriving the signals from said low frequency.

4. A radio signaling system comprising a transmitting station and a receiving station, the transmitting station comprising means for generating two sinusoidal waves of high frequencies, means for simultaneously superimposing a set of signals on both of said high frequencies, and means for transmitting said high frequencies upon which said signals are superimposed, the receiving station comprising means for receiving said high frequencies upon which said signals are superimposed, means for generating a sinusoidal wave of high frequency midway between said two high frequency waves, means for beating said high frequency with the received high frequencies upon which said signals are superimposed so as to obtain a subaudible frequency upon which said signals are superimposed, and means to derive the signals from said subaudible frequency.

5. A radio signaling system comprising a transmitting station and a receiving station, the transmitting station comprising means for generating two sinusoidal currents of high frequencies, means for simultaneously superimposing the same signals on said high frequencies, and means for transmitting said high frequencies upon which said signals are superimposed, the receiving station comprising means for receiving said high frequencies upon which said signals are superimposed, means for generating a sinusoidal current having a frequency located between said two received high frequencies, means for beating said high frequency with the received high frequencies upon which said signals are superimposed so as to obtain a low frequency upon which said signals are superimposed, means for transmitting said low frequency upon which said signals are superimposed to the exclusion of all higher frequencies resulting from modulation, and means for detecting the signals from said low frequency.

6. A radio signaling system comprising a transmitting station and a receiving station, the transmitting station comprising means for generating a pair of sinusoidal currents of high frequencies, means for simultaneously interrupting the currents of said high frequencies in accordance with telegraphic signals so that said signals may become superimposed thereon, and means for transmitting said high frequencies upon which said signals are superimposed, the receiving station comprising means for receiving said high frequencies upon which said signals are superimposed, means for generating a sinusoidal current of high frequency midway between the frequencies of the pair of currents generated at the transmitting station, means for beating said high frequency with the received high frequencies upon which said signals are superimposed so as to obtain a low frequency current modulated by said signals, means for filtering the products of beating so as to eliminate all frequencies higher than said low frequency, and means to detect the signals from said low frequency.

7. A radio receiving system comprising

means for receiving a pair of different high frequencies modulated in accordance with signals, both of said high frequencies being modulated by the same signals, means for generating a high frequency midway between said received high frequencies, means for beating said generated high frequency with said received high frequencies modulated in accordance with said signals so as to obtain a difference frequency, said difference frequency being modulated in accordance with the same signals, and means for deriving the signals from said difference frequency.

8. A radio receiving system comprising means for receiving two high frequencies each interrupted and thereby modulated in accordance with the same signals, means for generating a high frequency midway between said two high frequencies, means for beating said generated high frequency with said received high frequencies modulated in accordance with signals so as to produce a subaudible frequency modulated by the same signals, means for suppressing all frequencies except the subaudible frequency modulated by said signals, and means for detecting the signals from said subaudible frequency.

In testimony whereof, I have signed my name to this specification this 21st day of September, 1925.

RUSSELL S. OHL.