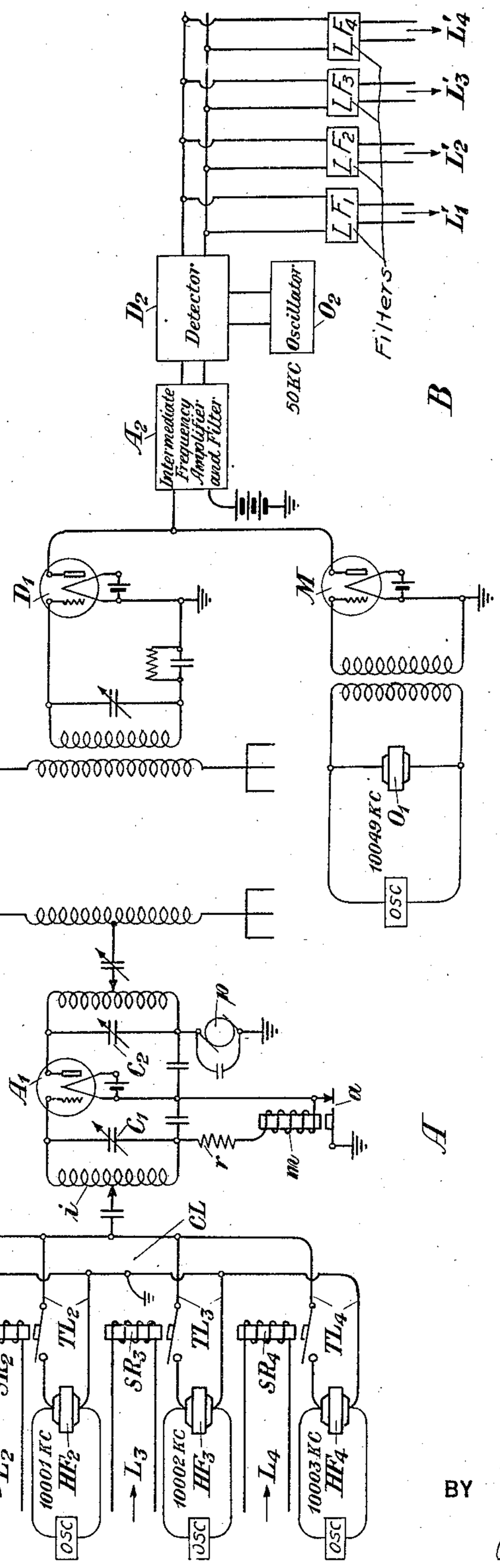
July 14, 1931. R. S. OHL 1,814,956

RADIO SIGNALING SYSTEM

Filed Aug. 26, 1925



INVENTOR
R. S. Ohl
BY
ATTORNEY

Patented July 14, 1931 1,814,956

UNITED STATES PATENT OFFICE

RUSSELL S. OHL, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

RADIO SIGNALING SYSTEM

Application filed August 26, 1925. Serial No. 52,652.

This invention relates to signaling systems, and particularly to multiplex signaling systems employing piezo-electric oscillators.

An object of the invention is to provide a plurality of signaling channels in the small range of the frequency spectrum.

Another object of the invention is to employ a plurality of piezo-electric oscillators to obtain a maximum number of signaling channels within a given frequency band.

A further object is to provide a signaling system in which carrier waves are locally supplied to the transmitting and receiving ends of such a signaling system so that the carrier waves will be at the same frequency or at the same frequency difference, as conditions necessitate.

This invention is applicable to signaling systems generally, and is illustrated as a radio signaling system wherein a plurality of messages may be transmitted from a single antenna or over a wire line and received by a plurality of receiving stations connected to a receiving antenna or a common wire line. It will be understood, however, that separate antennæ may be applied at either transmitting or receiving stations without impairing in any way the effectiveness of the invention.

The carrier waves employed in this invention are supplied to the various circuits of the system by means of one or more oscillation generators. Some of the oscillation generators employed in this invention are of the type known as piezo-electric oscillation generators, and such oscillation generators vibrate at frequencies which are substantially constant within narrow limits. By providing piezo-electric oscillation generators it is possible to reduce the allowance necessarily made in the frequency spacing between carrier waves of different signaling channels for variations in the frequency of the carrier waves. Consequently, it is possible to materially increase the number of channels employed in any given frequency range and still avoid interference between channels. Stated conversely, the band of the frequency spectrum required for transmitting a given number of signaling channels may be considerably reduced with the use of piezo-electric oscillators.

The nature of the invention will be pointed out with particularity in the appended claim, and the invention itself, both as to its objects and features, will be better understood from the description hereinafter following when read in connection with the accompanying drawing, showing a preferred embodiment of the invention.

Referring to the drawing, there is represented a multiplex radio signaling system in which a transmitting station is designated by the reference character A, and a receiving station is designated by the reference character B. At the transmitting station A there are a plurality of transmitting channels, TL_1, TL_2, TL_3 and TL_4, and a plurality of piezo-electric oscillators represented by the reference characters HF_1, HF_2, HF_3 and HF_4. For the purpose of illustration, let it be assumed that the piezo-electric oscillators employed at the transmitting station A vibrate at frequencies of 10,000, 10,001, 10,002 and 10,003 kilocycles, respectively. It will be understood that these oscillators may be any oscillators capable of setting up oscillations which are constant in frequency within very narrow limits, so that a plurality of such oscillators may be closely spaced and all arranged in a small band of the frequency spectrum.

A plurality of low frequency signaling channels, L_1, L_2, L_3 and L_4, are connected to corresponding low frequency signaling sources. The low frequency signaling channels L_1, L_2, L_3 and L_4 transmit currents which may have frequencies of 1, 2, 3 and 4 kilocycles, respectively, and each operates a signaling relay such as SR_1, SR_2, SR_3 and SR_4. When currents of 1, 2, 3 and 4 kilocycles flow through the respective channels L_1, L_2, L_3 and L_4 the corresponding relays SR_1, SR_2, SR_3 and SR_4, which are of any well known type readily responsive to alternating current of definite frequency, become energized. It will be understood, however, that if the channels L_1, L_2, L_3 and L_4 are employed merely to transmit direct current pulses characteristic of telegraph signals,

the relays SR_1, SR_2, SR_3 and SR_4 need be only of any simple direct current type, these relays becoming energized in accordance with the telegraphic pulses. When these relays are energized the oscillations of the piezo-electric oscillators are respectively modulated in accordance with the signals represented by the currents producing their energization. The modulated carrier waves in the transmitting channels TL_1, TL_2, TL_3 and TL_4 are then impressed on a common transmitting channel CL.

An amplifier A_1 is so arranged with respect to the signaling channels that the currents of the signaling channels are amplified thereby. This amplifier A_1 may be of any type well known in the art, but is preferably a vacuum tube amplifier. The input circuit of amplifier A_1 consists of the grid and cathode of the amplifier A_1, the inductance *i*, resistance *r*, and the winding of the electromagnetic relay *m*. The anode of the vacuum tube A_1 is supplied with space current by means of a source of potential *p*. When the input circuit of the amplifier A_1 is energized, direct current flows through the winding of the electromagnetic relay *m*, energizing said relay and attracting the armature *a*. By virtue of a grounded connection of the armature *a*, the source of potential *p* is connected to the anode of the amplifier A_1. However, when no current is impressed on the input circuit of the vacuum tube A_1 the winding of the electromagnetic relay *m* is deenergized and the armature *a* is released so that the source of potential *p* is disconnected from the output circuit of the amplifier A_1. The adjustable condensers c_1 and c_2 are respectively connected in the input and output circuits of the amplifier A_1 to prevent any stray or harmonic frequencies from being impressed on the circuits. The modulated carrier currents, as amplified by amplifier A_1, are impressed on the antenna at station A and are then transmitted to an antenna of station B.

At station B there is another piezo-electric oscillator O_1 which vibrates at a frequency, for example, 10,049 kilocycles, which is different from the frequencies of the piezo electric oscillators HF_1, HF_2, HF_3 and HF_4. The modulated carrier currents transmitted by the apparatus at station A are impressed on the input circuit of a detector D_1. The oscillations of the piezo-electric oscillator O_1 are impressed on the input circuit of the modulator M. The anodes of the detector D_1 and the modulator M are tied together so as to permit the oscillations of the piezo-electric oscillator O_1 to beat with the oscillations of the modulated carrier currents transmitted by the apparatus at station A. A filter and intermediate frequency amplifier A_2 is connected to the output circuits of the detector D_1 and the modulator M, the filter functioning to suppress all frequencies except the band of frequencies represented by the difference between the frequency of the oscillator O_1 and the modulated carrier frequencies transmitted by station A. Thus a band of intermediate frequencies of the order of 46, 47, 48 and 49 kilocycles, which are modulated in accordance with low frequency signals, is amplified by the amplifier A_2. It will be understood that the amplifier A_2 may be of any type well known in the art, preferably a vacuum tube amplifier.

Another oscillation generator O_2 is employed for beating with the band of intermediate frequencies. The frequency of this oscillation generator is different from the frequencies of the intermediate band, for example, 50 kilocycles. It will be understood that this oscillation generator may be of any well known type, preferably a vacuum tube oscillator. A detector D_2 is arranged so that the oscillations of the oscillator O_2 and the band of intermediate frequencies are beaten therein so as to reproduce the original signaling currents. A plurality of filters, for example, LF_1, LF_2, LF_3 and LF_4, are serially arranged with respect to the output circuit of the detector D_2, each freely transmitting the current of the corresponding low frequency signal transmitted from station A. Thus the filter LF_1 will transmit the signals impressed on the channel L_1 of station A to the channel L_1' at station B; filter LF_2 will transmit the signals impressed on the channel L_2 of station A to the channel L_2' at station B; the filter LF_3 will transmit the signals impressed on the channel L_3 of station A to the channel L_3' at station B; and the filter LF_4 will transmit the signals impressed on the channel L_4 of station A to the channel L_4' at station B. It will be understood that the filters employed herein are of any well known type, preferably the type known as the Campbell filters, described in Patent No. 1,227,113 to G. A. Campbell, dated May 22, 1917.

The arrangements of this invention operate in the following manner:

A plurality of high frequency signaling currents, all conveniently separated from one another and in a small range of the frequency spectrum, are generated by the oscillators HF_1, HF_2, HF_3 and HF_4. Each of these high frequency oscillations is modulated in accordance with a low frequency signal, such as is found in channels L_1, L_2, L_3 and L_4. The high frequency carrier currents as thus modulated are impressed upon the common transmitting channel CL, and are then transmitted to the input circuit of the amplifier A_1. After amplification by the amplifier A_1 the modulated high frequency carrier currents are impressed upon the antenna and are then transmitted to the distant station B.

Thus, the modulated carrier currents trans-

mitted by the apparatus at station A are impressed upon the antenna of station B and thence upon the input circuit of the detector D_1. The oscillations of the piezo-electric oscillator O_1 which has a frequency different from the frequencies of the carrier currents transmitted by the apparatus at station A, are impressed on the input circuit of the modulator M. The oscillations of this oscillator O_1 beat with the modulated carrier currents received from station A in the plate circuits of the detector D_1 and modulator M. Of the products of modulation a band of intermediate frequencies is selected and amplified by the amplifier A_2. Another oscillator O_2 sets up oscillations which beat with the band of the intermediate frequencies in the detector D_2. The frequency of the oscillator O_2 is different from the frequencies amplified by the amplifier A_2. As a result of the beating of these frequencies the original signaling frequencies are reproduced, these being then selected by filters LF_1, LF_2, LF_3 and LF_4 into the corresponding channels L_1', L_2', L_3' and L_4', respectively.

It will be understood that the frequencies employed herein are merely illustrative and others may be substituted therefor in practice as conditions necessitate.

While the invention has been 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 and scope of the invention as defined in the appended claim.

What is claimed is:

In a radio signaling system, in combination, a transmitting station including a plurality of oscillators connected in parallel relationship producing currents of different high frequencies which are closely spaced, a plurality of piezo-electric devices one coupled to each oscillator and maintaining the frequency of its current constant within very narrow limits, a plurality of relays one associated with each oscillator, the armature of each relay controlling the output of the corresponding oscillator, a plurality of lines one extending to the winding of each relay, currents of different low frequencies being transmitter over said lines each interrupted in accordance with signals and means capacitatively coupled to said high frequency oscillators for transmitting the high frequency currents modulated in accordance with said signals, and a receiving station including means for receiving said high frequency currents modulated in accordance with said signals, a first oscillator producing current of a frequency different from those frequencies received by said receiving means, a piezo-electric device coupled to said first oscillator for maintaining the frequency of the current produced thereby constant within very narrow limits, a three-element vacuum tube system to the output circuit of which said first oscillator is connected, said vacuum tube system beating the current of the frequency of said first oscillator with the plurality of currents of high frequencies modulated in accordance with signals received by said receiving means and producing a plurality of currents of intermediate frequencies interrupted in accordance with the same signals, a second oscillator, and means for beating the various currents of said intermediate frequencies interrupted in accordance with said signals and the current of said second oscillator in order to reproduce low frequency currents interrupted in accordance with said signals.

In testimony whereof, I have signed my name to this specification this 24th day of August, 1925.

RUSSELL S. OHL.