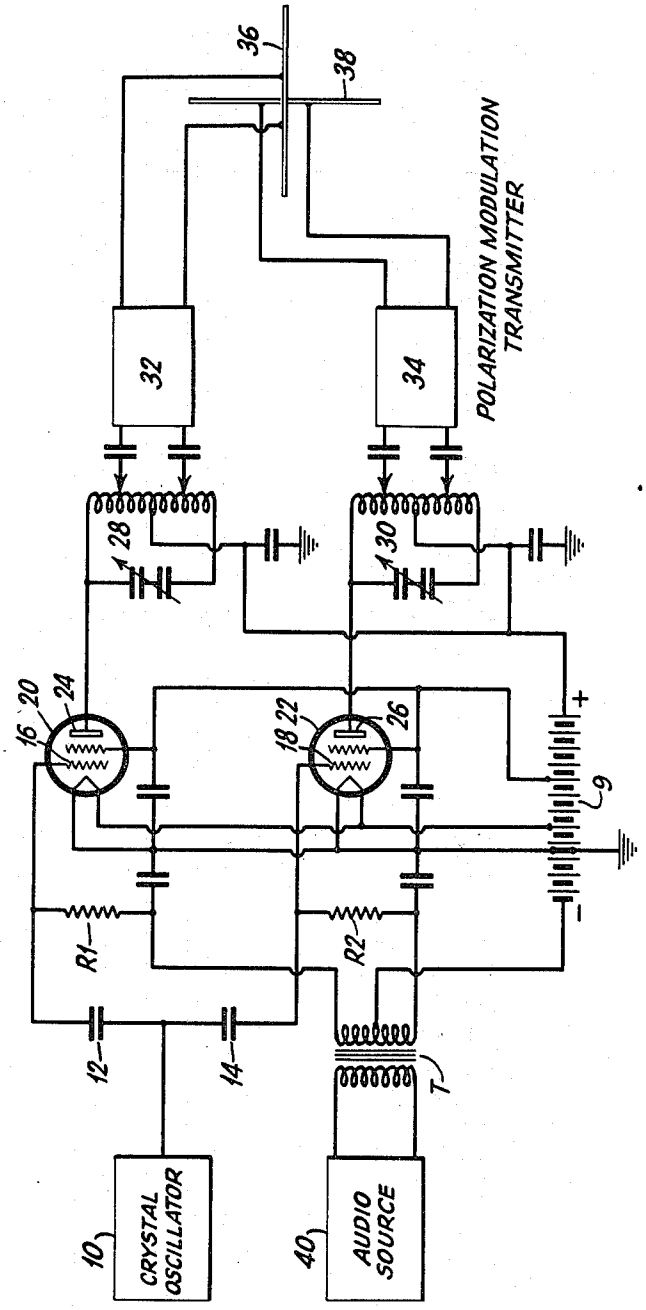
Feb. 24, 1942. G. L. USSELMAN 2,273,911

SYSTEM OF RADIO COMMUNICATION BY MEANS OF POLARIZATION MODULATION

Filed June 17, 1939 2 Sheets-Sheet 1

Fig. 1



INVENTOR.
GEORGE L. USSELMAN

BY H. S. Glover

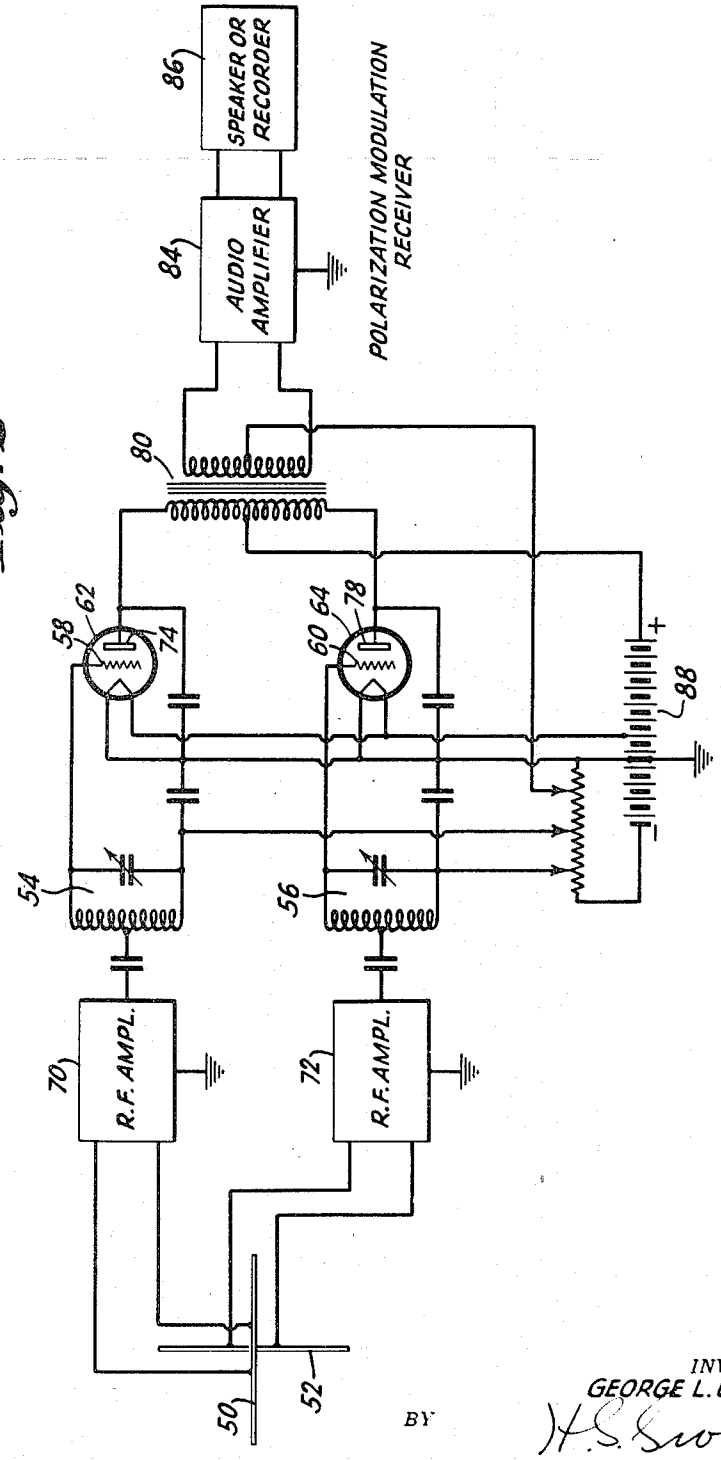
ATTORNEY.

Feb. 24, 1942. G. L. USSELMAN 2,273,911

SYSTEM OF RADIO COMMUNICATION BY MEANS OF POLARIZATION MODULATION

Filed June 17, 1939 2 Sheets-Sheet 2

Fig. 2



BY

INVENTOR.
GEORGE L. USSELMAN

H. S. Glover

ATTORNEY.

Patented Feb. 24, 1942 2,273,911

UNITED STATES PATENT OFFICE

2,273,911

SYSTEM OF RADIO COMMUNICATION BY MEANS OF POLARIZATION MODULATION

George L. Usselman, Port Jefferson, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application June 17, 1939, Serial No. 279,656

3 Claims. (Cl. 250—17)

This application concerns a new and improved method and means for radio communication, and, more particularly, a system of radio communication by means of polarization modulation.

It has been the practice in the prior art to transmit messages by means of amplitude, frequency or phase modulated signals, while the present invention uses polarization modulation as a means of signalling.

In describing my invention reference will be made to the attached drawings wherein Figures 1 and 2 together show an embodiment of my polarization modulation system.

In Fig. 1 and Fig. 2, I show a specific embodiment of one form of transmitter and receiver respectively, for radio communication by means of polarization modulated signals.

In the transmitter of Fig. 1 voltages characteristic of the wave to be modulated are supplied by source 10 to coupling condensers 12 and 14 and from condensers 12 and 14 in phase to the grids 16 and 18 of the two tubes 20 and 22. The anodes 24 and 26 of tubes 20 and 22 are connected to the tuned tank circuits 28 and 30 respectively. Tank circuits 28 and 30 are connected through amplifiers or frequency multipliers 32 and 34 respectively to antennas 36 and 38 respectively. The half-wave dipole antennas shown in Fig. 1 are for illustration purposes and they may be any suitable type. These antennas should be of a type to accentuate the polarization of the radiated waves. That is to say, the antennas 36 and 38 are of any suitable type, such as half-wave dipoles, which radiate waves polarized in different planes when the antennae are properly excited. For example, antenna 38 may radiate horizontally and antenna 36 may radiate vertically polarized waves. The antennas may be built in one unit or they may be built up in separate units.

It will be noted that antennas 36 and 38 in Fig. 1 are set in quadrature or 90° from each other so that the radiated waves will have their polarity 90° out of phase in space. This angle does not necessarily have to be 90° but may be any angle that proves to be most satisfactory for communication.

A source of modulating potentials 40 is coupled by a transformer T to the grid electrodes 16 and 18 of tubes 20 and 22 respectively.

In Fig. 2 I show a schematic circuit diagram of a receiver for reception of polarization modulated signals. 50 and 52 are the receiving antennas. These are shown as simple half-wave dipoles, though they may be of any suitable type of antenna and they may be built in one unit or they may be separated from each other. In Fig. 2 the antennas are set at 90° from each other but they may be set at any suitable angle giving best results. These two antennas are connected by transmission lines to the grid tank circuits 54 and 56 respectively. The tuned circuit 54 is coupled to the grid 58 of tube 62 while the tuned circuit 56 is coupled to the grid 60 of tube 64. Radio-frequency amplifiers 70 and 72 may be used as shown to amplify the signals received by antennas 50 and 52 for the grid circuits 54 and 56. The anodes 74 and 78 of tubes 62 and 64 are connected in phase opposition to the push-pull transformer 80. The output of transformer 80 is connected through audio amplifier 84 to loud-speaker or recorder 86. The power source for the detector is shown as 88.

The principle of operation is as follows:

Radio-frequency excitation voltage is supplied in parallel or cophasally to the control grids 16 and 18 of tubes 20 and 24 from the oscillator 10 Fig. 1. This carrier frequency is amplified or amplified and multiplied in tank circuits 28 and 30 and units 32 and 34 respectively, and then it is delivered to antennas 36 and 38 respectively. When there is no modulation present both antennas will radiate energy of equal intensity but this radiated energy will be polarized in different planes having a fixed polarization angle difference depending upon the position of antennas 36 and 38 and manner of excitation.

Now if audio-frequency signals are applied from source 40, they will be delivered in phase opposition through transformer T and resistors R1 and R2 to the control grids 16 and 18 of tubes 20 and 22. This signal then modulates the radio-frequency power to the antennas at an audio rate and since the audio modulation is in phase opposition, the radiation of one antenna will be a maximum when that of the other antenna is a minimum. The resultant radiated wave energy polarization will consequently swing back and forth through the radiation polarization angle of the antennas 36 and 38. Of course, this new system of radio communication may also be considered as operating over two paths of the same frequency. These two paths are oriented in space to have different polarization. The intelligence or signal is transmitted by differentially modulating the carrier energy of these two paths which have the unlike polarization.

The energy radiated from these transmitting antennas travels through space and some of it

reaches the receiving antennas shown in Fig. 2. The polarization position or direction of the signal energy may change during its transmission through space but it will still retain its polarization oscillation or modulation. The energy picked up by receiving antennas **50** and **52**, which are predominantly responsive to energy of a polarization corresponding to the polarization of the energy radiated by antennas **36** and **38** respectively, is transmitted through amplifiers **70** and **72** and tank circuits **54** and **56** to the grids of detector tubes **62** and **64** respectively. Tank circuits **54** and **56** are tuned to the signals received on antennas **50** and **52**. The grid biases of tubes **62** and **64** should be set for maximum efficiency as detectors. Now as the polarization of the incoming wave energy varies, it will be detected by tubes **62** and **64** and translated into low frequency or signal frequency push-pull current and voltages by transformer **80**. The audio-frequency signals from transformer **80** may be amplified by amplifier **84** and then transmitted to the loudspeaker or recorder **86**.

Antennas **50** and **52** should be of a type which is sensitive to changes in polarization of the received wave energy so that when the polarization is such that a maximum amount of energy is intercepted by one antenna, a minimum amount of wave energy is intercepted by the other antenna. Then, as the polarization of the received wave energy oscillates back and forth through an angle corresponding to the rate and intensity of the audio-frequency modulating signals in the transmitter, the changes in polarization will be detected in the receiver by the push-pull detector and amplified into audible signals in the loudspeaker.

The receiver may also be considered as a means for detecting and amplifying the signal oscillations from the transmitter which radiates carrier energy over two paths of different polarization but of the same carrier frequency, the amplitudes of the two carriers being differentially modulated according to the signal oscillations.

These specific embodiments may be modified in a number of ways. In a modification I may use a screen grid, four element tubes in the various stages of the transmitter, and, particularly, in the modulator stages of the transmitter.

What is claimed is:

1. The method of modulation which includes the steps of, producing polarized wave energy, producing other wave energy of like frequency polarized in a different sense, differentially modulating the amplitudes of said wave energies at signal frequency and separately radiating the energies so modulated.

2. The method of modulation which includes the steps of, producing polarized wave energy, producing other wave energy of like frequency polarized in a different sense, superimposing said wave energies to produce a resultant and differentially modulating the amplitudes of said wave energies at signal frequency to thereby correspondingly vary the polarization of said resultant between the polarizations of said produced wave energies as limits.

3. In a transmission system a first aerial arranged to radiate energy of one polarization, a second aerial arranged to radiate energy of a second polarization, a source of wave energy, a source of modulating potentials, two electron discharge devices each having input and output electrodes, means for impressing wave energy of like phase and frequency on said input electrodes, separate means for impressing amplified wave energy from the output electrodes of each of said tubes on said aerials, and means coupling said source of modulating potentials in phase opposition to corresponding electrodes in said devices for differentially modulating the impedances of said devices thereby modulating the amplitudes of the impressed wave energies at signal frequency.

GEORGE L. USSELMAN.