Dec. 11, 1928. 1,695,058

E. PETERSON

HIGH FREQUENCY SIGNALING

Filed Dec. 15, 1923

Fig. 1

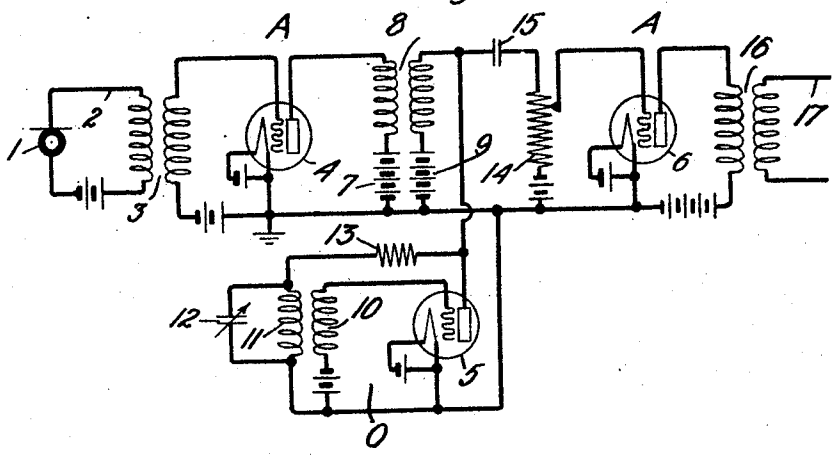


Fig. 2

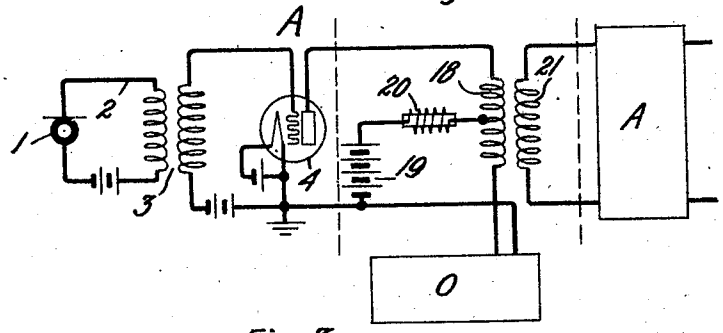
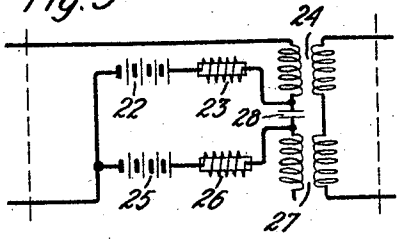


Fig. 3



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UNITED STATES PATENT OFFICE.

EUGENE PETERSON, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

HIGH-FREQUENCY SIGNALING.

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This invention relates to high frequency signaling and particularly to wave modifying systems.

It is an object of the invention to produce in a novel and effective manner, modulation of high frequency waves by a signal or other control wave, either for transmission or reception.

More specifically, the invention relates to a system in which a high frequency carrier wave is modulated in accordance with currents of speech frequency, thereby giving to the high frequency oscillations a speech signal wave form, some or all of the products of modulation then being impressed upon the transmission line.

In accordance with a feature of the invention, a modulating system is employed having a speech amplifier tube, an oscillator tube and if desired a third tube serving as an amplifier for the side band. The speech amplifier and oscillator tubes are so connected in circuit that the high frequency carrier wave generated in the oscillator is impressed on the speech amplifier tube, and the speech currents are also impressed on the oscillator so that modulation takes place in both the oscillator and amplifier tubes.

In accordance with another feature of the invention, means is provided to impress the modulation components from both of the modulating tubes upon a transmission line in additive phase relation. Briefly, this is accomplished by making the line connection to both tubes in parallel or in series depending upon the phase relation between the side bands produced in the two tubes.

The various features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic illustration of a carrier transmission system showing the method of coupling the speech amplifier and oscillator tubes to the transmission line when the side bands produced in the two tubes are in phase.

Fig. 2 represents a carrier transmission system showing the method of coupling the two tubes when the side bands produced in the tubes are out of phase.

Fig. 3 illustrates a modification of the system shown in Fig. 2.

Referring in detail to Fig. 1, a microphone 1 is included in a circuit 2, such as a telephone line, in which are produced low frequency signaling waves to be transmitted by modulating a high frequency carrier wave. The low frequency circuit 2 is coupled by means of a transformer 3 to the input circuit of a modulating system including a speech amplifying tube 4, an oscillator tube 5, and an amplifier tube 6 serving as an amplifier for the side band. Plate voltage is supplied to the speech amplifier tube 4 by a source of current 7 through one winding of a transformer 8, and plate voltage is supplied to the oscillator tube 5 by a similar source 9 through the other winding of the transformer. The transformer 8 serves to couple the plate circuits of the speech amplifier and oscillator tubes for the variation currents so that the speech variations are impressed on the oscillator, and the carrier oscillations are impressed on the speech amplifier. The purpose and effect of this coupling will be pointed out hereinafter.

The oscillator may have any desired circuit arrangement for the production of continuous waves to be modulated. As shown, the input circuit of the oscillator tube 5 includes a coil 10 which is connected between its cathode and control element. The tuned circuit of the oscillator includes a coil 11 shunted by a variable condenser 12 for determining the frequency of the oscillations generated. The coil 11 is coupled to the coil 10 and, as indicated by the arrow the condenser 12 may be adjusted to vary the period of the tuned circuit and hence the frequency of the oscillations generated. A resistance 13 is included between the oscillator anode and the tuned oscillatory circuit to limit the amplitude of the high frequency waves supplied from the oscillator output terminals to the tuned circuit 11, 12 in accordance with usual practice.

As stated hereinabove, the high frequency carrier current generated in the oscillator tube 5 is transmitted to the speech amplifier tube 4, and the amplified speech currents are likewise transmitted to the oscillator tube 5. Consequently modulation takes place in the speech amplifier tube as well as in the oscillator.

It has been found that where modulation results, as in the present case, from operating over the non-linear portion of the volt-ampere tube characteristic, the modulation components from two tubes associated according to the invention will be either in phase agree-

ment or in phase opposition. Heretofore in coupled-plate-circuit modulating systems in which the modulating action has been confined to one tube, it has only been necessary to couple the load circuit to one tube. Where modulation is produced in each of a plurality of tubes, in accordance with the invention, however, it is necessary to connect the load circuit to the two tubes in such a way that the modulating effect of one tube aids that of the other in producing useful modulation components in the load circuit.

In Fig. 1, the tubes 4 and 5 are connected in parallel with the outgoing circuit, this being the type of connection to be used when the side bands produced by modulation in the tubes 4 and 5 are in phase. Under these conditions the side bands are impressed on the input circuit of the tube 6 in phase addition. The output circuit of the tubes 4 and 5 is connected to the terminals of a potentiometer resistance 14 across which the amplifier tube 6 may be variably connected. The usual blocking condenser 15 is included in circuit with the potentiometer 14 to prevent the flow of direct current in the grid circuit of the tube 6. The wave resulting from the combination of the side bands produced in the tubes 4 and 5, is amplified in the tube 6 from which the amplified wave is then transmitted to the high frequency line 17 which is inductively coupled to the output of the tube 6 by means of a transformer 16.

In Fig. 2 a type of circuit is shown for use when the modulating tubes 4 and 5 produce side bands 180° out of phase with each other. Under these conditions, if the output connection described above were to be used, the side band amplitude would be reduced, perhaps to zero. In order to make the side bands produced by the two modulating tubes additive in effect, the outgoing or load circuit should be connected in series relation with the modulating tubes instead of in parallel with them. In the arrangement shown, the anode of the speech amplifier tube 4 and the anode of the oscillator tube 5 are connected in series relation with respect to the outgoing line through the induction coil winding 18. Space current is furnished for both tubes by means of the source of current 19 through the choke coil 20 which is designed to keep the sum of the space currents of the two tubes constant. As in the case of the system described in connection with Fig. 1, the path of the oscillator tube for variation currents is closed through the speech amplifier tube and the path of the speech amplifier tube is likewise closed through the oscillator tube, and consequently, modulation takes place in both tubes. The winding 21 in the input circuit of the amplifier tube 6 is inductively related to the winding 18, and the side bands produced in the tubes 4 and 5 are combined in an additive sense and are amplified in the tube 6, from which the amplified wave is transmitted to the high frequency line 17, as before.

Fig. 3 shows a modification of the system described in connection with Fig. 2 by means of which plate currents of different potentials may be supplied to the tubes 4 and 5. This modification may be substituted for the portion of the system included within the dotted lines of Fig. 2. In this case, plate current is supplied to the speech amplifier tube 4 from a source of current 22 through a choke coil 23, and the primary of an induction coil 24. Plate current is supplied to the oscillator tube 5 from a source of current 25 through a choke coil 26 and the primary of a transformer 27. A blocking condenser 28 is provided between the primary windings of transformers 24 and 27 to prevent the flow of direct current from either of the sources 22 or 25 through more than one plate circuit. The secondary windings of the transformers 24 and 27 are connected in the input circuit of the amplifier tube 6, in which the combined side bands are amplified before being transmitted to the line.

While for the purpose of illustration, the invention has been described in connection with a carrier signaling system, it will be understood that it is equally applicable to radio signaling systems.

The invention may also be embodied in forms other than those herein shown and described without departing in any way from the spirit of the invention, the scope of which is defined in the appended claims.

What is claimed is:

1. A transmission system comprising a source of low frequency signals, a vacuum tube for amplifying said signals, an oscillator serving as a source of high frequency oscillations, means for modulating said high frequency oscillations in accordance with said low frequency signals in both said amplifying tube and said oscillator, a transmission circuit, means for impressing the side bands produced by modulation in both of said modulating means upon said circuit in like phase, and a vacuum tube in said transmission circuit for amplifying the side bands impressed thereupon.

2. In a transmission system, a modulator comprising a three-element vacuum tube for amplifying signal currents and a three-element oscillator tube for generating a high frequency wave, said tubes having their grid circuits independent of each other, coupling means between the anodes causing modulation to take place in both tubes, and an outgoing circuit cumulatively associated with the anodes of said tubes with respect to the modulated waves.

3. In a transmission system, a modulator comprising a speech amplifier tube and an oscillator tube, each having space discharge

electrodes, separate sources of space current therefor, means in series with said sources of space current for impressing the output of each tube upon the other, whereby modulation takes place in both tubes, an outgoing circuit, and means for impressing modulation components from both of said tubes upon said circuit in like phase.

4. In a transmission system, a modulator comprising a speech amplifier tube and an oscillator tube each having space discharge electrodes, separate sources of space current therefor, means in series with said sources of space current for keeping constant as regards signaling variations the total space current supplied to both of said tubes and for impressing the product of each tube upon the other, whereby modulation takes place in both tubes, an outgoing circuit, and means for impressing modulation components from both of said tubes upon said circuit in like phase.

5. In a signaling system, a modulator comprising a three-element vacuum tube for amplifying signal currents and a three-element oscillator tube for generating a high frequency wave, said tubes having their grid circuits independent of each other and their anodes coupled over a path of low impedance to waves of a frequency of said high frequency wave and the modulation products to permit modulation in both tubes, and an outgoing circuit associated with the anodes of said tubes in additive phase relation for the modulation products for conveying modulated waves.

6. A signaling system comprising a signal wave amplifying device of the space discharge type, a high frequency oscillation generating device of the space discharge type, means for impressing a normal space discharge potential on each device independent of the normal impedance of the other, means for impressing the potential variations developed in each device upon the discharge space of the other device, whereby modulation takes place in both devices, an outgoing circuit, and means for impressing modulation components from said amplifying and generating devices upon said circuit in additive phase relation.

7. A signaling system comprising a vacuum tube of the audion type for amplifying signaling currents, an oscillator tube of the audion type for generating a high frequency wave, a two-winding transformer having one winding in circuit with the anode of said amplifier tube and the other winding in circuit with said oscillator tube, circuit means associated with said transformer and said tubes causing modulation to take place in both tubes, and an outgoing circuit cumulatively associated with the anodes of said tubes with respect to the modulated waves.

8. In a signaling system, a modulator comprising a speech amplifier tube and an oscillator tube, each having space discharge electrodes, separate sources of space current therefor, a transformer having one winding connected between the anode of said amplifier tube and one source of space current and its other winding connected between the anode of said oscillator tube and the other source of space current, whereby modulation takes place in both tubes, and an outgoing circuit associated with the anodes of said tubes for conveying modulated waves.

In witness whereof, I hereunto subscribe my name this 12th day of December, A. D. 1923.

EUGENE PETERSON.