DE WITT C. TANNER.

SYSTEM FOR ELECTRICAL SIGNALING.

APPLICATION FILED MAR. 8, 1919.

1,416,077.

Patented May 16, 1922.

Fig. 1.

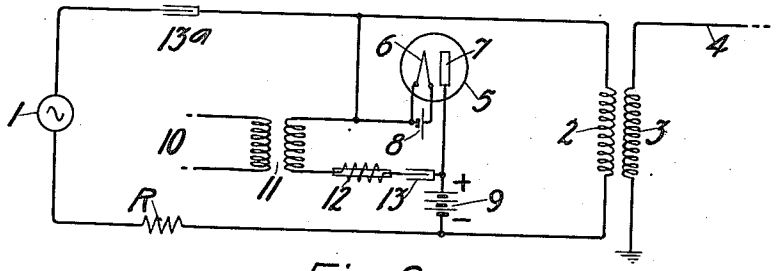


Fig. 2.

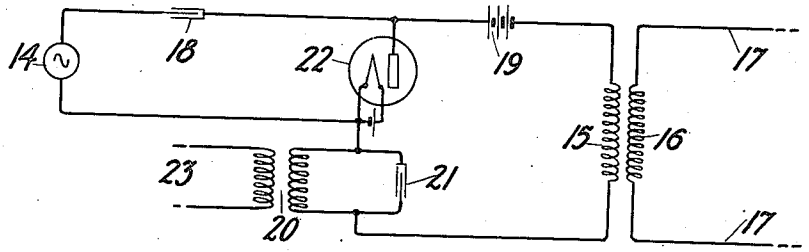


Fig. 3.

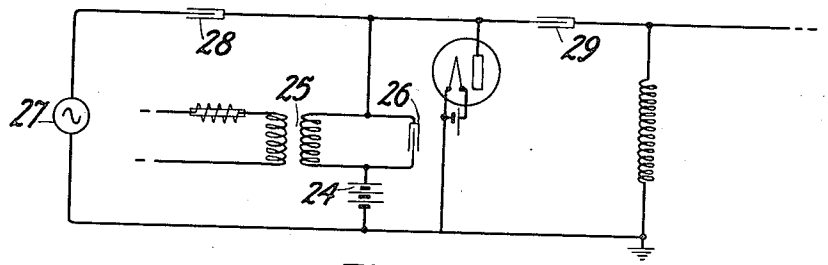
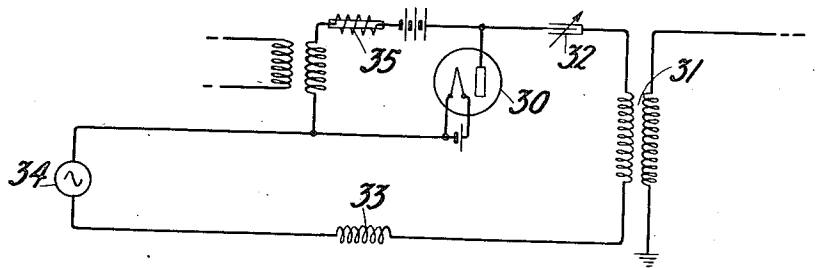


Fig. 4.



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UNITED STATES PATENT OFFICE.

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SYSTEM FOR ELECTRICAL SIGNALING.

1,416,077. Specification of Letters Patent. Patented May 16, 1922.

Application filed March 8, 1919. Serial No. 281,459.

To all whom it may concern:

Be it known that I, DE WITT C. TANNER, a citizen of the United States, residing at Glen Ridge, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Systems for Electrical Signaling, of which the following is a full, clear, concise, and exact description.

This invention relates to systems for electrical signaling, and more particularly to circuits and apparatus for modulating high frequency electrical oscillations or impulses in accordance with signaling currents or other low frequency electrical variations.

The principal object of this invention is to provide a modulating circuit in which a two-element electron discharge device may be used as a modulator.

According to this invention, high frequency oscillations are impressed across the terminals of a two-element electron discharge device simultaneously with low frequency electrical variations, which may be signaling currents such as are used in telephony and telegraphy, control currents, or impulses such as are used in selecting systems. A source of unidirectional current maintains an electron discharge between the electrodes of the discharge device, and the effect of the high frequency and low frequency oscillations is to cause a variation in the electron discharge. This variation component gives rise to an alternating current of the high frequency and of an amplitude varying in accordance with that of the low frequency current.

In the drawing, Figs. 1, 2, 3 and 4 illustrate diagrammatically different forms of modulating systems according to this invention.

Referring to Fig. 1, a high frequency or carrier current source 1, is in series with primary winding 2 of a transformer or translating device having a secondary winding 3 by means of which carrier frequency oscillations are impressed upon the line or antenna 4 connected thereto. A path including electron discharge device 5 and unidirectional current source 9, is in shunt to primary winding 2 and diverts from it a portion of the energy supplied by source 1. The electron discharge device 5 preferably comprises an exhausted vessel containing a cathode 6 and an anode 7. The cathode may be a filamentary conductor heated by current from an external source 8. Unidirectional current source 9 supplies space current to device 5. A signaling or control circuit 10 includes the primary winding of a low frequency transformer 11, the secondary winding of which has one terminal connected to the cathode 6 and the other, through high frequency retard coil 12 and stopping condenser 13, to anode 7. A resistance R and stopping condenser 13^a are connected in series with oscillator 1. Condenser 13^a may be omitted if resistance R is made sufficiently large to prevent the path through oscillator 1 from affording a relatively low resistance path for unidirectional current from source 9.

The operation of this system may now be readily understood. Bearing in mind that a regularly varying unidirectional space current through the discharge tube 5 is in effect a constant direct current with an alternating current superimposed thereupon, it will be seen that the high frequency oscillations from source 1 are divided between the primary 2 of the transformer and the path including the modulator element 5. The characteristic of modulator tube 5 is such that the high frequency oscillation component which it passes is not determined alone by the electromotive force of source 1 but may be varied in accordance with variations in electromotive force across the tube produced by another source. The tube 5 may be said to have a "curved characteristic", meaning thereby that the curve plotted between impressed electromotive force and corresponding value of space current for different values of the impressed electromotive force is not linear. In the system under consideration these electromotive force variations are caused by the action upon the secondary winding of transformer 11 of the signal or control currents in circuit 10. Consequently, that portion of the total high frequency oscillation energy output of source 1, which is passed through tube 5, varies in accordance with the currents in circuit 10. Condensers 13 and 13^a confine the unidirectional current from the space current source to a single circuit, and high frequency retard coil 12 prevents path 11, 12, 13 from shunting any of the high frequency oscillations. Condenser 13^a may be of such size as to permit the high fre-

quency current to pass readily therethrough but to offer high impedance to the low frequency current. Condenser 13 is preferably large, so as to offer low impedance to the low frequency currents. As the energy diverted from the winding 2 by modulator 5 varies in accordance with signals, the remaining energy supplied by the winding 3 to the line or antenna will likewise vary. As the current through resistance R varies, the drop of potential across R likewise varies. This causes the resultant effective electromotive force applied from source 1 to element 5 to vary in like manner and hence increases the effect of changes in the space current due to signals. The energy transmitted by the line or antenna will therefore be in the form of carrier oscillations of the frequency generated by source 1, modulated or varying in amplitude in accordance with the varying currents of circuit 10.

In the system of Fig. 2, a high frequency source 14 supplies high frequency oscillations to primary winding 15 of a transformer having a secondary winding 16 connected in a load or work circuit 17 which, as in the case of the circuit arrangement of Fig. 1, may be a high frequency signaling line or antenna. Also included in this circuit are a stopping condenser 18, similar to condenser 13^a of Fig. 1, a space current source 19 and a secondary winding of a transformer 20, this winding being shunted by a condenser 21 which furnishes a path for high frequency oscillations but offers high impedance to low frequency currents. A modulator tube 22 is connected in parallel to that part of the circuit comprising elements 19, 15, 20 and 21, and accordingly diverts a portion of the high frequency energy from transformer winding 15. The operation of this arrangement is similar to that of the arrangement of Fig. 1 and will be understood without further explanation.

The circuit arrangment of Fig. 3 differs from that of Fig. 1 in several respects. The space current source 24 is placed in series with the secondary winding 25 of the low frequency transformer, and, instead of a high frequency retard, a capacity element 26 associated with winding 25 to form a closed oscillation circuit tuned to the high frequency, is used. This tuned loop circuit 25, 26 offers substantially infinite impedance to oscillation currents supplied by source 27. Condenser 28 serves to prevent direct or low frequency current from flowing through the high frequency generator 27. Condenser 29 offers low impedance to both low and high frequency current while preventing the flow of direct current. A line or work circuit is connected to the modulator circuit by an auto-transformer.

Fig. 4 illustrates a further modification in which a modulator tube 30 serves as an impedance in series with the primary winding of the output transformer 31 rather than in a circuit in parallel with it, as in Figs. 1, 2 and 3. Consequently variations in the high frequency oscillations are repeated by transformer 31 to the line or work circuit. Variable capacity stopping condenser 32 has, in this circuit, an additional function, in that it serves with inductance 33 to tune the series circuit including the oscillator 34 and elements 30, 32 and 33 to the currents of the high frequency generated by source 34. Retard coil 35 prevents high frequency current from passing around the tube 30.

The work circuit in each of the four arrangements described may, in the case of signaling apparatus, be a line or an antenna, and it may be connected to the modulator circuit either inductively, as in Figs. 1, 2 and 4, or directly as in Fig. 3.

Although four distinct circuit arrangements have been illustrated and described, it is to be understood that the invention is not to be limited to these specific systems or to the specific features of the circuit arrangements involved, but only by the scope of the appended claims.

What is claimed is:

1. A source of carrier currents, two parallel paths connected to said source, one of said paths comprising an electron discharge device having a cathode and an anode, the other of said paths being closed and having associated therewith a translating device, and means connected to said cathode and anode for varying the impedance of said device in accordance with signals.

2. A closed signaling path, a source of high frequency currents connected thereto, a variable impedance device comprising a cathode and an anode in shunt to said path, and an impedance controlling circuit connected to said cathode and to said anode.

3. A source of carrier oscillations, a closed signaling path connected to said source, an electron discharge device comprising a cathode and an anode in shunt to said path, and means connected to said cathode and to said anode whereby the impedance of said electron discharge device may be varied.

4. In combination, a source of carrier currents, an electron discharge device having a cathode and an anode connected to said source, a closed transmission path in parallel to said device, and means connected to said cathode and anode for varying the impedance of said device in accordance with signals.

5. A source of carrier currents, a closed signaling path connected thereto, an electron discharge device comprising a cathode and an anode in shunt to said signaling path, and a control circuit including a source of

signaling electromotive force connected to said cathode and anode.

6. In combination, an electron discharge device having a cathode and an anode, a source of high frequency current connected by alternating current conductors to said cathode and anode, a source of low frequency current connected by alternating current conductors to said cathode and anode and a closed transmission path, other than said alternating current conductors, connecting said cathode and anode.

7. In combination, a variable impedance device comprising an evacuated container including a cathode and an anode, means for impressing high frequency electromotive forces upon said device, a transmission conductor connecting said cathode and anode by a closed alternating current path, and means for impressing variable electromotive forces between said cathode and anode whereby the impedance of said device may be varied.

8. In combination, a source of carrier currents, a variable impedance comprising a cathode and an anode connected thereto, a a closed transmission path connected with said source by alternating current conductors, and means for impressing between said cathode and anode electromotive forces varying in accordance with signals whereby the impedance of said device may be varied.

In witness whereof, I hereunto subscribe my name this 4th day of March, A. D. 1919.

DE WITT C. TANNER.