Oct. 16, 1934. E. A. TUBBS 1,977,536

ELECTRICAL SYSTEM

Filed Nov. 25, 1932

Fig. 1.

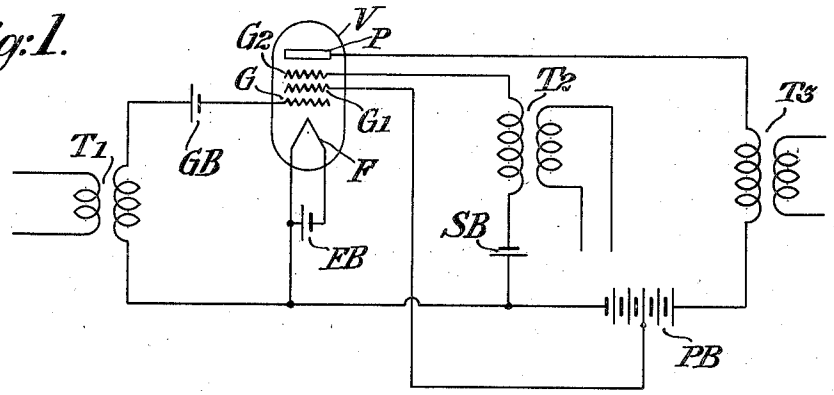


Fig. 2.

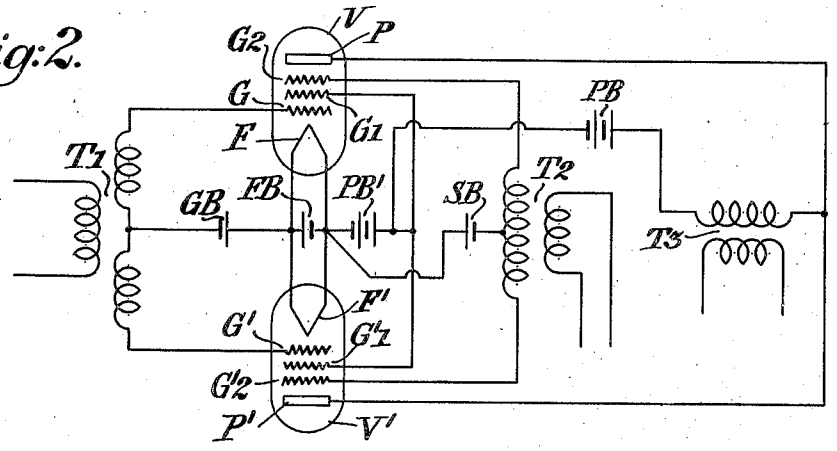
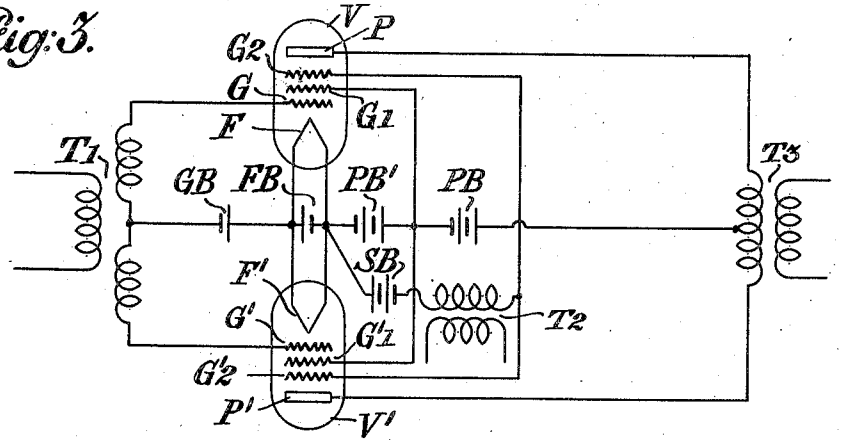


Fig. 3.



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ELECTRICAL SYSTEM

Ernest A. Tubbs, Long Island City, N. Y.

Application November 25, 1932, Serial No. 644,249

11 Claims. (Cl. 179—171)

This invention relates to electrical systems, and particularly to those electrical systems involving the conversion or translation of electrical energy effects from one form to another.

An object of my invention is to translate from one form to another certain of the electrical effects generally essential to electrical communication practices.

Examples of the conversion and translation results contemplated by me are modulation to produce so-called modulated carrier currents; detection to extract signal representing effects from modulated carrier currents; and heterodyning different frequency electrical oscillations to produce a third or beat oscillation.

Further objects and the features of my invention will be understood by reference to the figures of the drawing in connection with the following description thereof, like reference characters representing like parts in the several figures so far as permissible.

Figures 1, 2 and 3, constituting the drawing, diagrammatically illustrate different embodiments of my present invention, the choice of a particular embodiment depending upon considerations hereinafter particularized.

Various circuits of the systems of the several figures include by conventional showing energizing sources of potential, such as the batteries conventionally indicated by alternate long and short lines, and using the short line side of the conventional showing to represent or indicate the negative sides of the various potential sources throughout the systems of the several figures is followed throughout. In other words, the polarities of energizing at one place or another in the several embodiments are readily determined by inspection of the figures. For example, noting in Fig. 1 the connection of grid G1 of tube V to an indicated point of positive potential in plate battery PB establishes that grid G1 is positively energized, but less positively energized than anode P.

Fig. 1 illustrates an arrangement capable of effective modulation of an electrical oscillation by a second electrical oscillation. An electron tube V of the well-known pentode form for example, including usual heated cathode F, inner or control grid G, screen grid G1, outer or so-called suppressor grid G2, and anode P, is connected to receive on its control grid G the electrical oscillations intended to be modulated, this from a suitable source connected to supply these oscillations through transformer T1 as shown.

The grid G of tube V is selectively negatively energized by potential source GB to assure faithful repeater effect, or amplified repeater effect if it be present, by the action of tube V on the incoming oscillations.

The modulating oscillating energy is introduced from its source through transformer T2 onto outer grid G2. This outer grid is maintained negatively energized by the source of potential SB, preferably to such a degree that the maximum positive operating potentials developed on outer grid G2 by the modulating oscillations will not completely overcome the negative status originally established. In other words, the adjustment should preferably be such that outer grid G2 never draws current from the space discharge path in following the variations of potential thereon imposed by the impressed modulating oscillations.

It is generally appreciated by the art that the biasing potential on an electrode located to effectively influence current flow in a space discharge path can be so chosen that the variations therefrom within practical limits produce modifications in the space current flow which are quite effectively substantially linearly proportional to the magnitudes of the variations, this being generally viewed as working on the linear portion of the so-called characteristic output curve of such devices. Expressed in another way, it may be said to be possible to so initially adjust the energizing of a space discharge influencing element that variations within limits on each side of the setting will not materially alter the mutual conductance or amplification factor of the device.

Prior developed practices for modulation of one electrical oscillation by another electrical oscillation with the aid of electronic repeaters or repeating amplifiers usually involve bringing the interacting oscillations into contact through circuits with parts thereof so much in common or so closely associated as to make quite difficult design of satisfactory arrangements for accommodating the different contributing oscillations.

Referring to Fig. 1, it is seen that in my arrangement the oscillations to be modulated and the modulating oscillations are impressed upon appropriate electrostatically isolated elements of tube V through wholly independent, non-reactively isolated circuits, and that the resulting modulated oscillations depart from the region of contact so established by way of the wholly independent output circuit leading to output transformers T3 from anode P of tube V. Re-

ferring to Fig. 1, it is seen that the screen grid G1, interposed between inner grid G and outer grid G2, positively energized as it is by battery PB, effectively electrostatically isolates the inner and outer grids from each other.

The arrangement also provides for independent selection of the potential of potential source GB for properly biasing control grid G for best repetition or amplifying repetition of the oscillations to be modulated, and for independent selection of the potential of potential source SB for properly biasing outer grid G2 for assured faithful modulation results.

Sources of potential FB and PB provide for energizing the cathode, screen grid and anode of tube V respectively in normal manner for causing the tubes to function as intended.

The system of Fig. 2 functions to erase from the output or resultant oscillations certain of the characteristics of the source or initial oscillations. Two like pentode tubes V and V', constituted and energized as described for tube V in Fig. 1, are connected as shown, which is in accordance with well understood practice.

It is apparent that with the arrangement so adjusted that equal but oppositely acting potentials of an oscillation incoming through transformer T1 are applied to control grids G and G' of like acting tubes V and V', the resulting output oscillations will pass through the primary winding of transformer T3, common to the two circuits, in opposing fashion, and there will be no fundamental oscillating energy induced into the work circuit connected across the secondary of transformer T3.

Likewise, if equal and oppositely acting potentials of an oscillation incoming through transformer T2 are applied to outer grids G2 and G'2, no indication of the fundamental thereof will appear in the output work circuit.

The perfection of these results obviously depends upon how closely the two tubes are equivalent in their functioning, and how closely the paralleled circuits are balanced. In the case of unequal parallel operation for any reason, the degree of energy of unwanted characteristic that may pass over into the output work system depends upon the degree of acceptability of the output work system for the frequency of the escaping oscillation. In many usual practices the acceptability factor or tuning of the output work system is so far removed in periodicity from that of the possible unwanted but escaping oscillation energy as to make the matter of selection of tubes and balancing of the paralleled circuits of no serious practical consequence.

As to use that may be made of the capabilities of the system of Fig. 2, it is apparent that if oscillations of different characteristics are simultaneously applied to the system through input transformers T1 and T2, the output components of the oscillations will interact to assert their differences wherever the two oscillations may meet. They meet in the primary of output transformer T3, and there develop potential disturbances representative of their differences, which disturbances are induced into the output work circuit. If the output system is tuned favorably to the periodicity of the manifested difference, it resonantly or more acceptably takes over the oscillations to be used as oscillating electrical energy freed of the characteristics possessed originally in the two separate sources.

For example, the operation may amount to simple heterodyning or beat frequency production. The oscillation introduced through transformer T1 may be of pure sine form of one high frequency and the oscillation introduced through transformer T2 also of pure sine form of another high frequency, with the result that an oscillation of pure sine form of frequency equal to the difference between the frequencies of the original oscillations, and free other than in amplitude from the characteristics thereof, appears in the output working system.

As another example, the T1 introduced oscillation may be of pure sine wave high frequency nature, and the T2 introduced oscillation of a range of varied low or audio frequency representative of voice, music or other varied sound. In this case the output oscillations through output transformers T3 will not be the original T1 oscillation merely varied in amplitude in accordance with the varying T2 oscillation, but rather a series of so-called "side band" oscillations made up of heterodyne produced or beat frequency oscillations resulting from interactions between the original T1 oscillation and the various sound representing oscillations of the T2 oscillation.

The T2 oscillation, in the matter of its original frequency characteristic, is not present in the output result other than to the extent it uses lack of perfection in practical tube construction and circuit balance to evade its sought elimination.

The system of Fig. 2 may be used to function effectively as a so-called detector, being a complete demodulator of usual signal modulated oscillation. For example, if either an originally introduced T1 or T2 oscillation is but the usual modulated carrier current common to radio telephone and like interrupted continuous wave radio practice, the amplified carrier currents per se are extinguished at output transformer T3, but the signal representing modulations thereof effect output transformer T3 to manifest themselves for the physical reasons heretofore stated by Carson in his United States Patent 1,343,306 of June 15, 1920, commencing line 114, page 2, to line 83, page 3 of the said patent.

Fig. 3 differs from Fig. 2 in having input transformer T2 connected to impress oscillating potentials on the outer grids G2 and G'2 of tubes V and V' in step or symmetry rather than in the opposition fashion shown in Fig. 2. Obviously, this modification in the arrangement can be effected as well by leaving input T2 in Fig. 3 as it is in Fig. 2, and inverting input T1 in Fig. 3.

The result of this modification is that the one of the oscillations applied to both grids out of step acts in step in the push-pull type of output transformer T3 shown, and therefore is present in the output system along with the reactive or beat effects if the system is used in connection with oscillations simultaneously impressed on both input systems.

Fig. 3 also differs from Fig. 2 in the mode of connection of output transformer T3 into the system. In Fig. 2 the whole of the primary of output transformer T3 is connected to be common to the output circuits of the two tubes, whereas in Fig. 3 the output transformer T3 is connected in so-called push-pull fashion, the primary winding being split by the output circuits of the two tubes as shown. The result is that if two or more oscillations of different frequencies, or modulated oscillations, are applied,

as may be necessary in some practices, to the same grids through either one of the inputs, the beat oscillations or detection oscillations thereof will not appear in the output oscillations of Fig. 3. In other words, the appearance of beats or other distortion oscillation effects is only had as between oscillations applied to different pairs of grids.

While I have illustrated the use of two separate tubes in the systems of Figs. 2 and 3, it is, of course, appreciated that the same results and effects can be had by embodying the two controllable space discharge paths needed in a single tube, a construction not uncommon in tube production of today. Additionally, arrangements employing more control elements than usual to the pentode type of tube may be used.

While I have limited the description of my invention to only those adaptations thereof necessary to an understanding of the novel features embodied, no limitations are intended thereby beyond those imposed by the appended claims. Nothing herein is intended to waive any patentable features of my copending application for Letters Patent of the United States, Serial Number 737,948, filed August 1, 1934.

Having fully described my invention I claim:

1. In an electrical system the combination of a continuous electron discharge path comprising an electron emitting cathode and a positively energized anode, a plurality of negatively energized electrodes spaced between said cathode and anode and electrostatically isolated from each other by an electrode interposed therebetween, a plurality of sources of oscillations, and means for impressing different ones of said oscillations upon different ones of said negatively energized electrodes, the negative energizing of a one of said electrodes between said interposed electrode and said anode being so proportioned that substantially no current is thereby drawn from said electron discharge path during operation, whereby fidelity of operation is enhanced.

2. In an electrical system the combination of a pair of like continuous electron discharge paths each comprising an electron emitting cathode, a positively energized anode and a pair of differently spaced interposed electrodes, said electrodes being electrostatically isolated one from the other by an electrode interposed therebetween, two sources of oscillations, means for negatively energizing said interposed electrodes, connections for separately impressing the energies of said oscillations each on the like ones of the negatively energized interposed electrodes, and means for transferring the resulting oscillations imposed on the anodes of said paths.

3. In an electrical system, the combination of an electronically active path comprising an electron emitting source and an appropriately spaced therefrom positively energized anode, differently spaced control electrodes interposed between said source and said anode, said control electrodes being electrostatically isolated one from the other by an electrode interposed therebetween, separate sources of electrical oscillations, separate means for impressing one of said oscillations between said electron emitting source and one of said control electrodes, separate means for impressing another one of said oscillations between said electron emitting source and a control electrode farther removed therefrom, and means for so negatively polarizing said farther removed electrode that in operation substantially no current is thereby drawn from said electronically active path, whereby fidelity of operation is enhanced.

4. In an electrical system, the combination of an electron discharge path comprising an electron emitting cathode and a cooperating positively energized anode, a pair of differently spaced grid electrodes interposed in said path, said grid electrodes being electrostatically isolated one from the other by an electrode interposed therebetween, a pair of separate sources of electrical oscillations having separate connections for separately impressing them one between said cathode and the nearer thereto one of said grid electrodes, and the other between said cathode and the farther removed therefrom grid electrode, and means for so negatively energizing at least said farther removed grid electrode that substantially no grid current is drawn thereby from said path during operation, whereby fidelity of operation is enhanced.

5. In an electrical system, the combination of an electronically active path comprising an electron emitting source and an appropriately spaced therefrom positively energized anode, differently spaced electrodes interposed between said source and said anode, an electrode between two of said interposed electrodes positively energized to a lesser degree than said anode, separate sources of electrical oscillations, separate means for impressing one of said oscillations between said electron emitting source and one of said interposed electrodes located between said source and said positively energized interposed electrode, separate means for impressing another one of said oscillations between said electron emitting source and a control electrode on the far side of said positively energized interposed electrode, and means for so negatively polarizing said far side electrode that in operation substantially no current is thereby drawn from said electronically active path, whereby fidelity of operation is enhanced.

6. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises constantly attracting electrons of said stream to an intermediate position in said path, negatively repelling electron movement at a position beyond said intermediate position, modulating the density of the attracted electrons by variably polarizing that part of said electron stream subjected to said constant attraction, further attracting electrons to said anode, and causing said alternating current to vary said negative repelling of electron movement less than enough on the positive half cycles of the alternating current to draw substantially no electrons from said electron movement, whereby the fidelity of modulation is enhanced.

7. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, negatively repelling electron movement at a position beyond said intermediate position, modulating the density of the attracted electrons by variably polarizing said stream at a position ahead of said intermediate position, further attracting electrons to said anode, and causing said alternating current to vary said negative repelling of electron movement less than enough on the positive half cycles of the alternating current

to draw substantially no electrons from said electron movement, whereby the fidelity of modulation is enhanced.

8. The method of modulating electrical alternating current in an electronically active path having an electron emitting source, an anode and an electron stream space path therebetween, which comprises constantly attracting a substantial part of the electrons of said stream to an intermediate position in said path, modulating the density of said constantly attracted electrons, further attracting electrons to said anode, causing said alternating current to vary said further attraction, and sufficiently negatively polarizing the varying of said further attraction that substantially no electrons are drawn from said electron stream on the positive half cycles of the alternating current, whereby the fidelity of modulation is enhanced.

9. The method of modulating electrical alternating current in an electronically active path having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, modulating the density of the attracted electrons by variably polarizing said stream at a position in advance of said intermediate position, further attracting electrons to said anode, causing said alternating current to vary said further attraction, and sufficiently negatively polarizing the varying of said further attraction that substantially no electrons are drawn from said electron stream on the positive half cycles of the alternating current, whereby fidelity of modulation is enhanced.

10. In a system for modulating electrical alternating current, a thermionic tube comprising an electron emitting source, a pair of electrodes relatively close together, the said electrode nearer said electron emitting source being positively energized and the other one of said electrodes being negatively energized, a positively energized anode beyond said negatively energized electrode, a source of alternating current connected to said negatively energized electrode, an electrode interposed between said electron emitting source and said pair of electrodes, and a second source of alternating current connected to said last mentioned electrode, said negatively energized electrode being sufficiently so energized that substantially no current is drawn thereby during the positive half cycle of the impressed thereon alternating current, whereby the fidelity of modulation is enhanced.

11. In a system for modulating electrical alternating current, a thermionic tube comprising an electron emitting source, a pair of negatively energized electrodes and an interposed therebetween positively energized electrode, a positively energized anode beyond said electrodes, and separate sources of alternating current connected to said negatively energized electrodes, the one of said electrodes nearer to said anode being sufficiently negatively energized that substantially no grid current is drawn thereby during operation, whereby fidelity of modulation is enhanced.

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