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CARRIER WAVE TRANSMITTER

Filed Feb. 3, 1936

Fig. 1

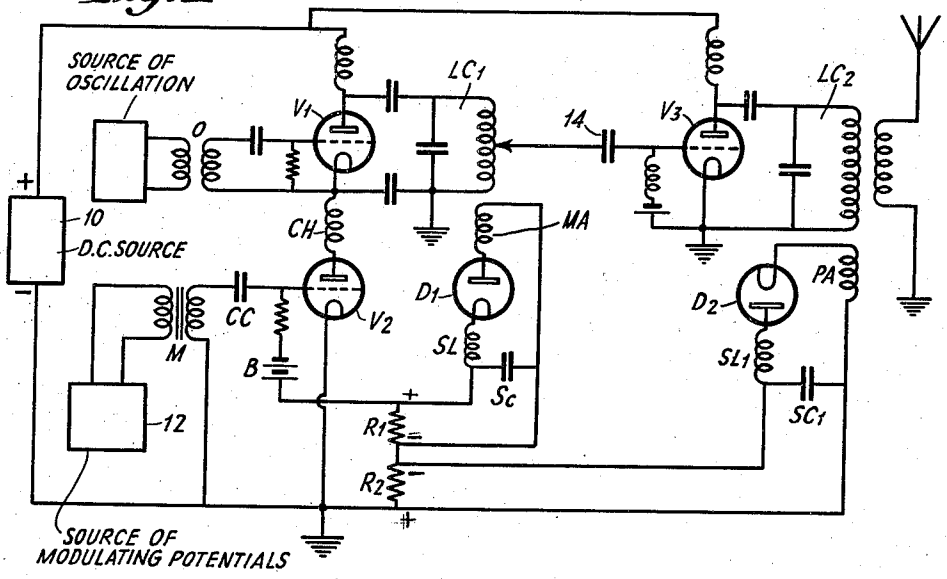


Fig. 2

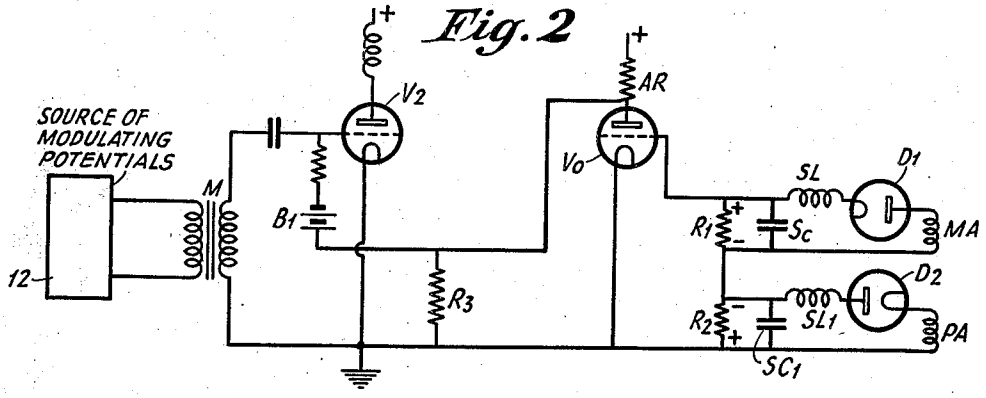
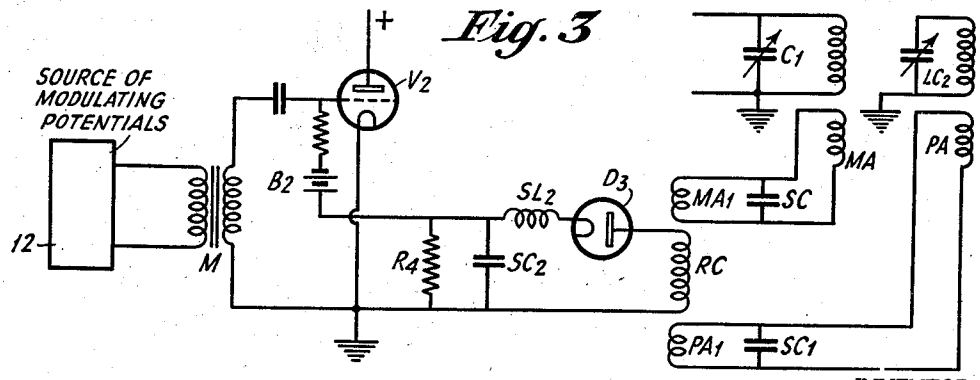


Fig. 3



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CARRIER WAVE TRANSMITTER

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10 Claims. (Cl. 179—171)

This invention relates to modulated carrier wave transmitters and more particularly to transmitters of the kind wherein the modulated carrier energy is amplified before transmission.

It is common practice at the present time to modulate high frequency carrier wave oscillations either in a circuit of the oscillator generating those oscillations or in a circuit of an amplifier "driven" by the oscillator and then to subject the modulated oscillations to further amplification in a power amplifier before actual transmission, e. g., before radiation from an antenna. The advantage of effecting modulation in this manner at a comparatively early stage of the transmitter, i. e., at a stage where the power level is low is that it is a relatively simple matter to effect "deep" modulation without material distortion; in other words, it is a relatively simple matter to obtain substantially rectilinear modulation if modulation be applied at an early stage where the power is low. In practice, however, with this type of transmitter difficulty is experienced in avoiding distortion in and by the power amplifier which is between the stage at which modulation is effected and the antenna or other output circuit of the transmitter. In high power transmitters, this difficulty becomes very serious for if with known arrangements the operating conditions be made such that there is no risk of distortion, the said conditions will not be such as will give good efficiency.

The principal object of the present invention is to avoid this difficulty and to provide an improved transmitter of the kind wherein amplification of the modulated carrier wave energy is effected.

According to this invention in a transmitter of the kind wherein the carrier wave oscillations are modulated so that substantially distortionless modulated carrier wave energy appears in a circuit which is followed by an amplifier for amplifying said modulated carrier wave energy, means are provided for differentially combining energy derived from said circuit and from a circuit of the amplifier which follows it and utilizing the differentially combined energy to apply compensation at a point in the transmitter preceding said amplifier in such manner that so long as a predetermined relationship exists between the two differentially combined energies, no compensation is applied, but if said predetermined relationship is departed from, compensation is applied in such direction as substantially to compensate for that departure.

There will now be described with reference to Figs. 1, 2 and 3, of the accompanying diagrammatic drawing, three embodiments of the invention as applied to transmitters of the series modulation type. It is, however, to be understood that the invention is not limited to such transmitters, but is of general application irrespective of the type or method of modulation employed.

Referring to Fig. 1, high frequency carrier wave oscillations from a source are applied via a coupling at O between the control grid and the cathode of a high frequency amplifier tube V1, whose anode-to-cathode space is in series with the anode-to-cathode space of a modulating tube V2, the arrangement preferably being the usual series modulation arrangement shown and wherein a series circuit extends from the positive terminal of a source of anode potential 10 from the anode to the cathode of the high frequency amplifier tube V1, then through a choke CH to the anode of the modulating tube V2, from the anode to the cathode of the said modulating tube, and then to earth and the negative terminal of the source of anode potential 10. Modulating potentials are applied from a source 12 via transformer M through a suitable coupling condenser CC between the control grid and the cathode of the modulating tube V2. The grid-to-cathode circuit of this modulating tube includes in series the usual grid resistance, a source B of suitable negative bias potential, and two bias resistances R1, R2. Connected to the anode of the high frequency tube V1 is the usual tuned output circuit LC1 which in turn is coupled by a condenser 14 to the grid of a power tube V3 which serves to amplify the modulated carrier wave energy fed thereto. The anode to cathode circuit of this power tube also contains the usual tuned output circuit LC2. Inductively coupled to the inductance in the tuned output circuit LC1 of the high frequency tube V1 at which modulation is effected is a coil MA which is in series in a loop circuit with a suitable rectifier D1, e. g., a diode, and a smoothing inductance SL and condenser SC and the terminals of this condenser are connected across the resistance R1. Coupled to the inductance in the tuned output circuit LC2 of the power tube V3 is an inductance PA which is similarly in series with a loop circuit with a rectifier D2, smoothing inductance SL1, and condenser SC1 and the said condenser SC1 is connected across the other bias resistance R2 in the grid-cathode circuit of the modulating tube V2. The sense of connection of the rectifiers is such that rectified potentials set up across the bias resistance R1

oppose those across the bias resistance R2 and the adjustments of the circuits are such that as long as the modulated carrier wave energy in the output circuit LC2 of the power tube V3 is an accurate repetition of that in the output circuit LC1 of the high frequency tube V1, the algebraic sum of the potentials set up across the two bias resistances R1, R2 is zero. If, however, the modulated carrier wave energy in the output circuit LC2 ceases to be an accurate repetition of that in the output circuit LC1, the potential set up across one of the two series-connected bias resistances R1, R2 will become greater than that set up across the other with the result that the total grid bias upon the modulating tube V2 will vary in a direction and to an extent sufficient to cause compensation for the distortion in question.

In some cases it will not be found sufficient to add the rectified potentials from the rectifiers directly in the direct current grid circuit of the modulating valve and in such cases a direct current amplifier may be interposed; in other words, the two bias resistances R1, R2 which in Fig. 1 are in the grid-cathode circuit of the modulating tube V2, may be as shown in Fig. 2 included instead in the grid circuit of a direct current amplifier tube V0, and the anode of this tube may be connected through a suitable source of fixed bias B1 in series with a grid resistance to the grid of the modulating tube V2, the anode of the said direct current amplifier tube V0 being also connected to a suitable source of anode potential, such as source 10, through a resistance AR and also through a further resistance R3 to the common cathode point of the modulating tube V2 and the said direct current amplifier tube V0.

The systems illustrated in Figs. 1 and 2 can be arranged to provide automatic compensation for distortion arising by reason of departure from rectilinearity both at the upper and lower bends of the characteristic curve of the power amplifier tube. Where, however, it is sufficient to provide for compensation for curvature at or near one end only of the characteristic of the power amplifier tube, a somewhat simpler arrangement can be used, this simpler arrangement employing only a single rectifier. In this simplified arrangement, which is illustrated in Fig. 3, the output circuit of the power amplifier tube V3 (not shown in Fig. 3) and the output circuit of the tube V1 at which modulation is effected (also not shown in Fig. 3) are differentially coupled via coils MA1, PA1, respectively, to a common coil RC which is in series in a loop circuit with a rectifier D3, a smoothing inductance SL2, and a condenser SC2, and this condenser has its terminals connected across a single bias resistance R4, which is in series with a fixed bias source B2 and a grid leak between grid and cathode of the modulating tube V2.

It will be appreciated that it is not necessary in carrying out this invention to utilize the differentially combined potentials to vary the grid bias of the modulating tube; for example, the said differentially combined potentials may be utilized to provide the required compensation by varying the grid bias on the power amplifier tube itself. In general, however, the specifically described method of varying the grid bias upon the modulating tube is preferred since if control be effected by varying the grid bias upon a power amplifier tube, disturbing effects due to grid current are likely to occur.

What is claimed is:

1. In a signalling system, a plurality of electron discharge tubes each of which has input and output electrodes, alternating current circuits for impressing wave energy of carrier wave frequency on the input electrodes of one of said tubes and from the output electrodes of said one of said tubes to the input electrodes of another of said tubes, a modulating impedance variable at signal frequency connected with an electrode in said one of said tubes to modulate said wave energy, and supplemental means for additionally modulating said wave energy when the modulated wave energy in the output of said other of said tubes is not a substantial repetition in wave form of the modulated wave energy in the output of said one of said tubes, including rectifying means differentially coupling an electrode of each of said tubes to said modulating impedance to additionally control the impedance thereof.

2. In a signalling system, a plurality of electron discharge tubes each of which has input and output electrodes, alternating current circuits for impressing wave energy of carrier wave frequency on the input electrodes of one of said tubes and from the output electrodes of said one of said tubes to the input electrodes of another of said tubes, a modulating impedance controllable at signal frequency connected with an electrode in said one of said tubes to modulate therein said wave energy, a supplemental impedance connected with said modulating impedance for regulating the value of said controllable modulating impedance, and differential circuits including rectifying means coupling the output electrodes of each of said tubes to said supplemental impedance to impress additional controlling potentials thereon when the modulated wave energy in said other of said tubes is not substantially a repetition in wave form of the modulated wave energy in said one of said tubes.

3. In a signalling system, a plurality of electron discharge tubes each of which has input and output electrodes, high frequency alternating current circuits for impressing wave energy on the input electrodes of one of said tubes and from the output electrodes of said one of said tubes to the input electrodes of another of said tubes, a modulating impedance variable at signal frequency connected with an electrode in said one of said tubes to modulate said wave energy, a pair of supplemental impedances connected with said modulating impedance for regulating the value of said modulating impedance, and rectifiers differentially coupling the output electrodes of each of said tubes to said supplemental impedances.

4. In a signalling system, a plurality of discharge devices each having a control electrode, an anode and a cathode, alternating current circuits for impressing wave energy on the control electrode and cathode of one of said devices and from the anode and cathode of said one of said devices on the control electrode and cathode of another of said devices, a modulating tube having electrodes, the impedance between a pair of which is connected in series with the impedance between the anode and cathode of said one of said electron discharge devices, means for impressing modulating potentials on an electrode of said modulating tube, supplemental means for impressing other potentials on an electrode of said modulating tube when the energy in said other of said devices is not a substantial repetition of the energy in said one device, and cir-

cuits each including a rectifier coupling said supplemental means differentially to the output electrodes of said one of said devices and to the output electrodes of said other of said devices.

5. In a signalling system, a plurality of electron discharge devices each having a control electrode, an anode and a cathode, alternating current circuits for impressing wave energy on the control electrode and cathode of one of said devices and from the anode and cathode of said one of said devices on the control electrode and cathode of another of said devices, a modulating tube having a control grid, an anode and a cathode, means connecting the impedance between the anode and cathode of said tube in series with the impedance between the anode and cathode of said one of said discharge devices, means for impressing modulating potentials on an electrode of said modulating tube, supplemental means for impressing correcting potentials on an electrode of said modulating tube when the energy in the output of said other of said devices is not a substantial repetition of the energy in the output of said one of said devices, and circuits including rectifiers coupling said supplemental means differentially to the output electrodes of said one of said devices and to the output electrodes of said other of said devices.

6. In a signalling system, a plurality of electron discharge devices each having a control electrode, an anode and a cathode, alternating current circuits for impressing wave energy on the control electrode and cathode of one of said devices and from the anode and cathode of said one of said devices on the control electrode and cathode of another of said devices, a modulating tube having electrodes including a control grid and a cathode, a circuit connecting the impedance between a pair of the electrodes in said tube in series with the impedance between the anode and cathode of said one of said discharge devices, means for impressing modulating potentials on the control grid of said modulating tube, supplemental means for impressing other potentials on the control grid of said modulating tube when wave distortion occurs in said devices or circuits, and circuits including rectifiers coupling said supplemental means differentially to the output electrodes of said one of said devices and to the output electrodes of said other of said devices.

7. In a signalling system, a plurality of electron discharge devices each having a control grid, a cathode and an anode, alternating current circuits for impressing wave energy on the control grid and cathode of one of said devices and from the anode and cathode of said one device to the control grid and cathode of another of said devices, a modulating tube having an anode, a cathode and a control grid, circuits connecting the anode and cathode of said modulating tube in series with the anode and cathode of said one of said electron discharge devices and with a source of direct current potentials, means for impressing modulating potentials on the control grid and cathode of said modulating tube, a circuit for impressing a biasing potential between the control grid and cathode of said modulating tube, a pair of impedances in said circuit, a pair of rectifiers having input electrodes and having output electrodes differentially connected with said pair of impedances and a coupling between the input electrodes of one of said rectifiers and the anode and cathode of said one of said electron discharge devices and between the input electrodes of the other of said rectifiers and the anode and cathode of the other of said electron discharge devices.

8. In a signalling system, a plurality of electron discharge devices each having a control grid, a cathode and an anode, alternating current circuits for impressing wave energy on the control grid and cathode of one of said devices and from the anode and cathode of said one device to the control grid and cathode of another of said devices, a modulating tube having an anode, a cathode and a control grid, circuits connecting the anode and cathode of said modulating tube in series with the anode and cathode of said one of said electron discharge devices and with a source of direct current potentials, means for impressing modulating potentials on the control grid and cathode of said modulating tube, a circuit for impressing a biasing potential between the control grid and cathode of said modulating tube, an impedance in said circuit, an amplifier tube having input electrodes and having output electrodes connected to said impedance, a pair of rectifiers having input electrodes and having output electrodes differentially connected with the input electrodes of said amplifier tube, and a coupling between the input electrodes of one of said rectifiers and the anode and cathode of said one of said electron discharge devices and between the input electrodes of the other of said rectifiers and the anode and cathode of the other of said electron discharge devices.

9. In a signalling system, a plurality of electron discharge devices each having a control grid, a cathode and an anode, alternating current circuits for impressing wave energy on the control grid and cathode of one of said devices and from the anode and cathode of said one device to the control grid and cathode of another of said devices, a modulating tube having an anode, a cathode and a control grid, circuits connecting the anode and cathode of said modulating tube in series with the anode and cathode of said one of said electron discharge devices and with a source of direct current potentials, means for impressing modulating potentials on the control grid and cathode of said modulating tube, a circuit for impressing a biasing potential between the control grid and cathode of said modulating tube, a rectifier having input electrodes and having output electrodes connected with said last named circuit, a coupling between the input electrodes of said rectifier and the anode and cathode of said one of said electron discharge devices and a coupling between the input electrodes of said rectifier and the anode and cathode of the other of said electron discharge devices said couplings being differential.

10. In a signalling system, a plurality of electron discharge amplifying devices each having a control electrode, an anode, and a cathode, a source of oscillations of carrier wave frequency, an alternating current input circuit coupling the control electrode and cathode of one of said devices to said source of oscillations, an alternating current output circuit coupling the anode and cathode of said one of said devices to the control electrode and cathode of another of said devices, an alternating current output circuit connected with the anode and cathode of said other of said devices, a source of modulating potentials, an additional electron discharge device having an anode, a cathode, and a control grid, a circuit coupling the control grid and cathode of said additional device to said source of modulating potentials, a circuit including a

source of potential connecting the anode and cathode of said additional device in series with the anode and cathode of said one of said devices, an impedance connected in a direct current circuit between the control grid and cathode of said additional device, a pair of rectifiers each having input and output electrodes, circuits coupling the output electrodes of said rectifiers differentially to said impedance, a circuit coupling the input electrodes of one of said rectifiers to the output circuit connected with the output electrodes of said one of said devices, and a circuit coupling the input electrodes of the other of said rectifiers to the output circuit coupled with the output electrodes of said other of said devices.

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