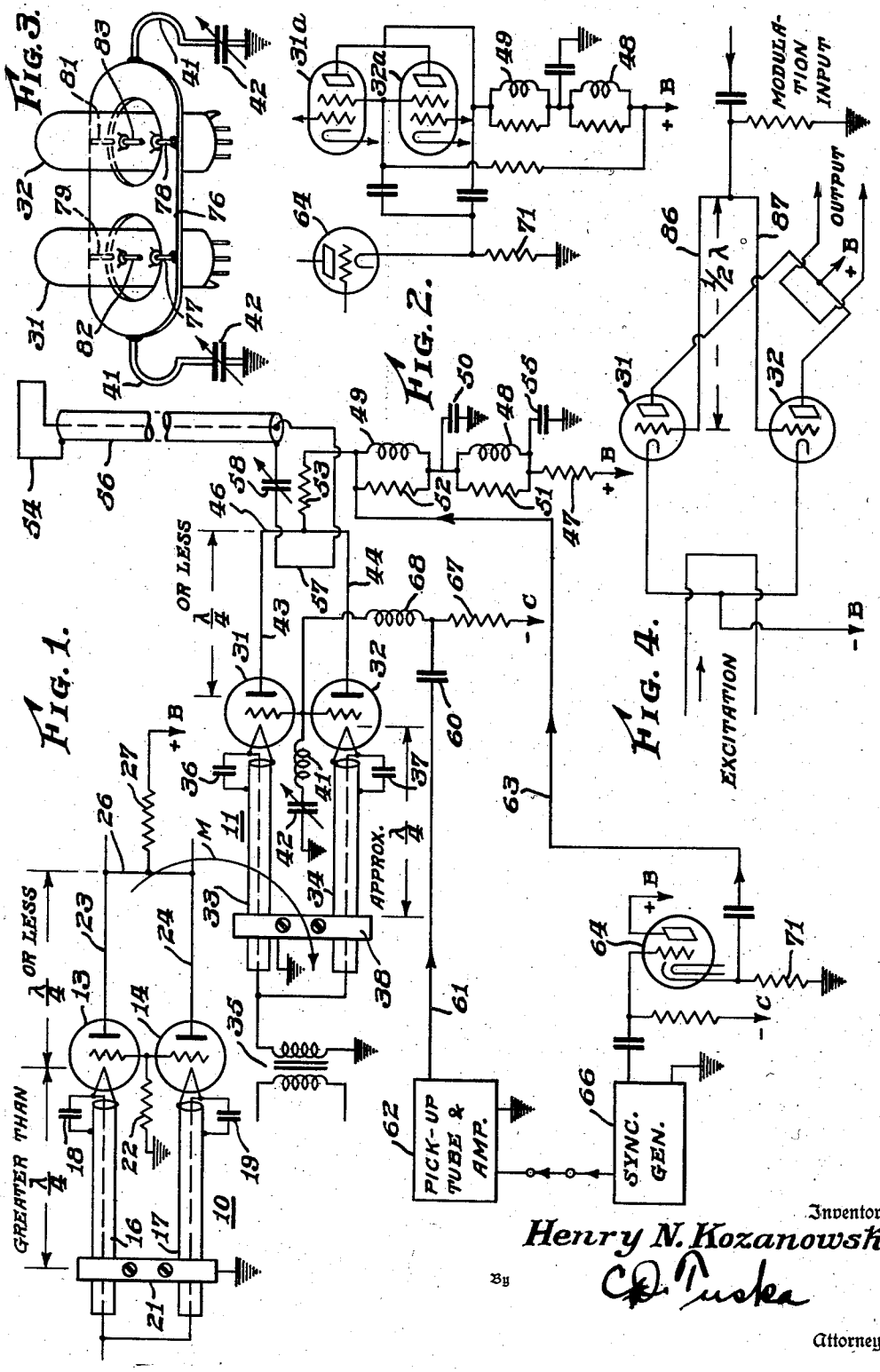
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NEW MODULATION SYSTEM FOR PORTABLE EQUIPMENT

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## NEW MODULATION SYSTEM FOR PORTABLE EQUIPMENT

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1

My invention relates to modulation and amplifier systems and particularly to improved methods of and means for transmitting picture signals or other high frequency signals.

In portable television equipment one of the problems is to obtain satisfactory synchronizing signal output from a transmitter with the minimum amount or weight of equipment. Another problem is to obtain satisfactory operation from available vacuum tubes at very high frequencies.

An object of the present invention is to provide an improved method of and means for modulating a radio transmitter by picture signals and synchronizing pulses.

Another object of the invention is to provide an improved amplifier for very high frequency signals.

In one of the preferred embodiments of the invention, as applied to a portable television transmitter in which a high frequency carrier wave is amplitude modulated by both picture signals and horizontal and vertical synchronizing pulses, the picture signal modulation is obtained by grid modulation while the synchronizing pulse modulation is obtained by plate modulation. In this way I avoid clipping the peaks of synchronizing pulses due to slight mistuning of the load, tank or grid circuit or due to a change in the total signal level that might result if grid modulation were employed for both synchronizing pulses and picture signal. Also, by employing plate modulation for synchronizing it is possible to radiate synchronizing pulses containing more power with a given type or size of power amplifier tube than is possible with grid modulation.

In accordance with another feature of the invention I avoid the necessity of cross-neutralization or the like in the power amplifier by utilizing triode amplifier tubes which have their control grids effectively grounded at the carrier frequency, the cathodes of the triodes being above ground potential at this frequency. Thus, the control grids function like screen grids to isolate the plate and grid circuits whereby feedback is prevented.

The invention will be better understood from the following description taken in connection with the accompanying drawing, in which

Fig. 1 is a circuit diagram of a television transmitter embodying my invention,

Fig. 2 is a circuit diagram of another embodiment of the invention,

Fig. 3 is a perspective view of a mechanical

2

arrangement of the power amplifier of Fig. 1, and

Fig. 4 is a circuit diagram of another embodiment of the invention.

In the several figures, corresponding parts are indicated by the same reference characters.

In Fig. 1 the invention is applied to a television transmitter comprising a high frequency oscillator 10 and a power amplifier 11, each having a tuned grid circuit and a tuned plate or anode circuit. The oscillator anode circuit is coupled to the amplifier grid circuit as indicated by the curved arrow M.

The oscillator 10 includes a pair of vacuum tubes 13 and 14, each including for example a directly heated cathode, a control grid and an anode. Heating current is supplied to each cathode through concentric lines 16 and 17. The sides of the cathode filaments that are connected to the inner conductors of the concentric lines are also connected to the outer conductors through capacitors 18 and 19 to provide low impedance and symmetry of circuit at the oscillator frequency. An adjustable shorting bar 21 is provided for tuning the line formed by the outer conductors of concentric lines 16 and 17. A grid leak resistor 22 is connected between the control grid of tubes 13 and 14 and ground. The anodes of tubes 13 and 14 are connected to the conductors 23 and 24 of a line tuned by a shorting bar 26. Anode voltage is supplied through a resistor 27.

The power amplifier 11 includes vacuum tubes 31 and 32, each including for example a directly heated cathode, a control grid and a plate or anode. As in the case of the oscillator, the cathodes of tubes 31 and 32 may be supplied with heating current through a pair of concentric lines 33 and 34 which are connected to a transformer 35. Capacitors 36 and 37 corresponding to capacitors 18 and 19 in the oscillator are provided. The outer conductors of lines 33 and 34 are provided with a grounded shorting bar 38 for tuning the cathode circuit.

The control grids of tubes 31 and 32 are connected to ground at the oscillator or carrier frequency through a series resonant circuit 41—42 tuned to said frequency. The cathodes of these tubes are above ground potential at the carrier frequency since they are connected to the quarter-wave line 33—34 which is grounded at the opposite end.

The anode or plate circuit for tubes 31 and 32 comprises parallel conductors 43 and 44 and a shorting bar 46 which tunes the line to a quar-

ter wave length or less. Plate voltage is supplied to the tubes 31 and 32 through a constant impedance network of a well known type which may comprise a resistor 47, a plurality of inductance coils 48 and 49 shunted by resistors 51 and 52, respectively. The network also includes shunt condensers 50 and 55. Resistor 53 is a low impedance resistor for preventing parasitic oscillations.

The output of the amplifier 31—32 may be supplied to an antenna 54 through a concentric line 56 which is inductively coupled to the quarter wave line 43—44 by a loop 57, the loop being tunable by a capacitor 58.

In accordance with my invention the carrier wave is grid modulated by picture signal supplied through a coupling condenser 60 and a conductor 61 from a pickup tube and amplifier 62, and it is plate modulated by horizontal and vertical synchronizing pulses supplied through a conductor 63 and a cathode follower tube 64 from a synchronizing pulse generator 66. The picture or video signal is impressed upon the grid circuit at the junction point of a grid resistor 67 and a peaking coil 68 through which bias is applied to the tube grids. This signal varies the control grids at video frequency with respect to cathode potential (also ground potential) although the grids remain at ground potential at the carrier frequency.

The synchronizing pulses appearing across the cathode resistor 71 of amplifier tube 64 may be applied to the junction point of resistor 53 and coil 49 whereby positive pulses applied to the grid of tube 64 drive the plates of tubes 31 and 32 more positive to increase their output during the occurrence of each synchronizing pulse.

The feature of amplitude modulating the grid with picture signals and the plate with synchronizing pulses has two important advantages. First, the peaks of the synchronizing pulses cannot be clipped as a result of the picture signal increasing in amplitude enough to move the "black" side of the signal into and possibly beyond the upper knee of the curve obtained by plotting power amplifier grid voltage against radio frequency output current. It may be noted that since the system shown in Fig. 1 employs A.-C. transmission (there being no D.-C. insertion) the "black" side of the picture signals may sometimes be moved beyond the upper knee of the curve also by an increase in the picture background component, that is, by the overall picture becoming lighter in tone. Secondly, more synchronizing power can be obtained from given power amplifier tubes since the synchronizing pulses may drive the plate voltages momentarily beyond any plate voltage that can be applied to the tubes continuously without damaging them.

It may aid in understanding my invention to point out why the advantages of the present invention cannot be obtained by utilizing plate modulation for both picture signals and synchronizing pulses. It will be apparent for one thing that more modulating power would be required since plate modulation inherently requires more power than grid modulation. The other difficulty with the use of plate modulation alone is that the power amplifier output impedance (i. e., the impedance of the constant impedance network) must be lowered as the frequency band of the plate modulating signal is increased. In the system shown in Fig. 1, the synchronizing signals have a frequency band width of about 1 megacycle whereas the picture signals have a frequency



band width of about 4 or 5 megacycles. Thus, it will be seen that if the plate modulation is by the synchronizing pulses only, the power amplifier modulation network (48—49, etc.) can be given a reasonably high impedance so that the power amplifier tubes 31 and 32 put out much more power than they would for the same modulation power if they were plate modulated by the picture signal having the wider frequency band.

As shown in Fig. 2, I may employ screen grid modulation in place of plate modulation, the system otherwise being the same as in Fig. 1. It will be noted that the synchronizing pulses are applied to both the screen grids and the anodes of the screen grid power amplifier tubes 31*a* and 32*b*. The modulating pulses are applied to the anodes as well as to the screen grids to prevent the pulses from driving the screen grids to a higher positive potential than the anodes.

In Fig. 3 I have illustrated how, in one particular design, the control grids of the power amplifier tubes were brought to ground potential at the carrier frequency. Instead of a single series resonant circuit 41—42 tuned to the carrier frequency, there are two such circuits in parallel (each inductance coil 41 being in the form of a half loop).

The two resonant circuits 41—42 are connected between ground and opposite ends of a conducting plate 76 which functions as a convenient bus bar to which the grid terminal leads or pins 77, 78, 79 and 81 are connected. Plate terminal pins are shown at 82 and 83. It has been found that if only one resonant circuit is connected between the plate 76 and ground, the neutralization or shielding may not be complete since different parts of the plate 76 tend to acquire different potentials because of currents induced by the high frequency carrier wave. The frequency of the carrier wave in the example described is of the order of 300 or 400 megacycles per second.

It will be apparent that the grids of amplifier tubes 31 and 32 must be held at ground potential at the side band frequencies as well as at the carrier frequency. This result is approximated closely enough in practice by giving the inductance coil 41 a very low inductance and the condenser 42 a comparatively high capacity (i. e. high capacity considering the frequency involved). For example, in Figs. 1 and 3 assuming the transmitter has a carrier frequency of 350 megacycles per second the condenser 42 has a capacity of about 10 micromicrofarads. As a result the impedance of the resonant circuit 41—42 slightly off the resonant point is still very low.

In Fig. 4 I have shown how the control grids of tubes 31 and 32 may be held at ground potential by means of a one-half wave length line 86—87 instead of by a series resonant circuit like the circuit 41—42 of Fig. 1. It will be understood that opposite ends of the one-half wave length line are at the same potential at the carrier freuency and that the end remote from the control grids is at ground potential or its equivalent since the amplifier circuit is of the balanced type. It follows that in this circuit, as in that of Fig. 1, the plate and grid circuits are shielded from each other at the carrier frequency by the effectively grounded control grids.

Since I avoid the use of cross-neutralization or the like, the tube capacity has not been doubled by the presence of neutralization condensers, and it is possible to use the tubes at about 50 per cent

higher frequency in practice than that permissible in a cross-neutralized circuit.

I claim as my invention:

1. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a control grid and a plate, a source of picture signals and synchronizing signals, said signals covering a wide frequency band and a comparatively narrow frequency band, respectively, means for amplitude grid modulating said amplifier by said picture signals and means for amplitude plate modulating said amplifier by said synchronizing signals, and a constant impedance network through which a direct-current operating voltage is applied to said plate, said network having a substantially constant impedance throughout said narrow frequency band and only throughout said narrow frequency band whereby it presents a maximum impedance to said synchronizing signals.

2. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a control grid, a screen grid, and a plate, a source of picture signals and synchronizing signals, said signals covering a wide frequency band and a comparatively narrow frequency band respectively, means for applying said picture signals to the control grid of said amplifier, means for applying said synchronizing signals to the screen grid and plate of said amplifier whereby the carrier wave is amplitude modulated by both of said signals, and a constant impedance network through which a direct-current operating voltage is applied to said plate, said network having a substantially constant impedance throughout said narrow frequency band and only throughout said narrow frequency band whereby it presents a maximum impedance to said synchronizing signals.



3. In a television transmitter, means for producing a carrier wave, an amplifier tube for amplifying said carrier wave, said tube having a cathode, a control electrode and at least one other electrode which is operated at a positive potential with respect to the cathode, a source of picture signals and synchronizing signals, said signals covering a wide frequency band and a narrow frequency band, respectively, means for applying said picture signals to said control grid to modulate said carrier wave as to amplitude and means for applying said synchronizing signals to said other electrode to further modulate said carrier wave as to amplitude, and a constant impedance network through which a direct-current operating voltage is applied to said other electrode, said network having a substantially constant impedance throughout said narrow frequency band and only throughout said narrow frequency band whereby it presents a maximum impedance to said synchronizing signals.

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