

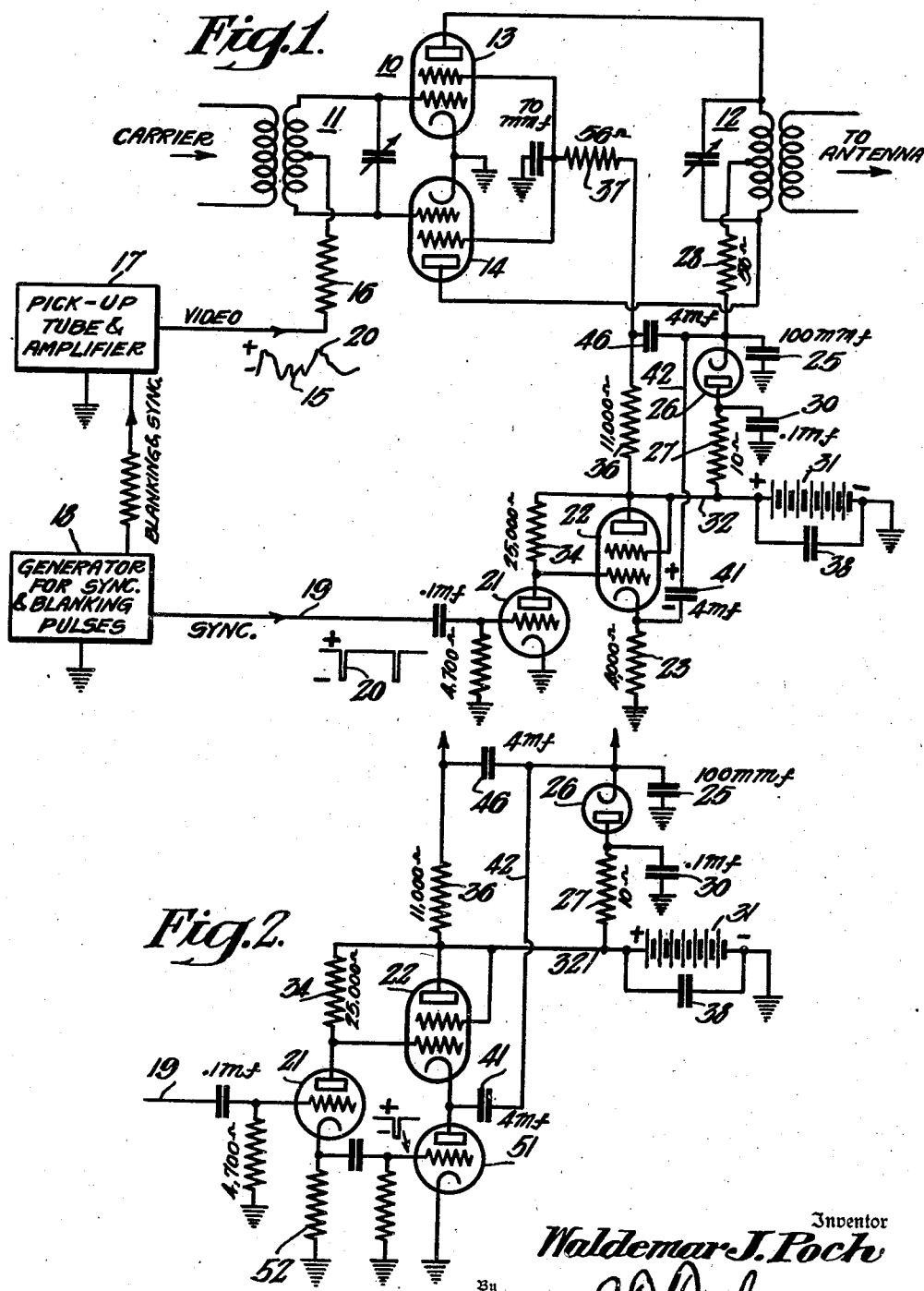
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MODULATION SYSTEM FOR TELEVISION

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MODULATION SYSTEM FOR TELEVISION

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My invention relates to modulation systems and particularly to modulation systems for television transmitters.

In portable television equipment one of the problems is to obtain satisfactory synchronizing signal output from a transmitter with the minimum weight of equipment. An object of the present invention is to provide an improved means for modulating a radio transmitter by picture signals and synchronizing pulses. Another object of the invention is to provide an improved system for modulating a carrier wave by a mixture of large amplitude pulses and smaller amplitude 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 both by picture signals and by horizontal and vertical synchronizing pulses, the picture signal modulation is obtained by grid modulation while the synchronizing pulse modulation is obtained by plate and/or screen grid modulation. A modulation system of this character is described and claimed in a co-pending application, Ser. No. 436,406, filed March 27, 1942, in the name of Henry N. Kozanowski, and entitled Modulation system of television. In accordance with my invention, I include a unilateral conducting device such as a diode in the plate modulating circuit. The diode provides the necessary impedance in the plate circuit for plate modulation during the occurrence of a pulse but it presents a low impedance for grid modulation during the occurrence of the interspersed picture signals.

The invention will be better understood from the following description in connection with the accompanying drawing, in which Fig. 1 is a circuit diagram of a television transmitter embodying my invention, and Fig. 2 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 shown applied to a television transmitter comprising a power amplifier 10 having a tuned grid circuit 11 and a tuned anode or plate circuit 12. The amplifier 10 includes vacuum tubes 13 and 14, each having a cathode, a control grid, a screen grid, and an anode or plate. A carrier wave is applied to the tuned grid circuit 11 as indicated. The amplifier output may be supplied from the tuned anode circuit 12 to an antenna (not shown).

In accordance with my invention the carrier wave is grid modulated by picture signal indi-

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cated at 15 which is supplied through a resistor 16 from a pickup tube and amplifier 17, and it is plate modulated by horizontal and vertical synchronizing pulses supplied from a synchronizing pulse generator 18 over a conductor 19 to an amplifier tube 21 which preferably is D.-C. coupled to an amplifier tube 22. Horizontal synchronizing pulses are indicated at 20. As will be explained below, the synchronizing pulses appear across a cathode resistor 23 of the amplifier tube 22 and are applied with positive polarity to the screen grids and plates of tubes 13 and 14 to increase their power output during the occurrence of each synchronizing pulse. In the specific example illustrated, the synchronizing pulses are applied to the control grids of tubes 13 and 14 along with the picture signal but this is not necessary as all synchronizing signals may be transmitted by the plate modulation.

The feature of amplitude modulating the grid with picture signals and amplitude modulating 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.

The use of plate or screen grid modulation in a system such as the one described in the above-mentioned Kozanowski application will degenerate the grid modulation to a certain extent because of the resistance required in the plate circuit of the power amplifier. According to my invention, I avoid this undesirable effect by utilizing a unilateral conducting device such as a diode 26 so connected that there is the necessary resistance in the plate circuit during plate modulation but substantially no resistance therein during grid modulation. Diode 26 is connected between the anode of amplifier tube 22

and the midpoint of the inductor in the tuned plate circuit 12, the diode plate being connected through a resistor 27 to the anode of tube 22, and the diode cathode being connected to said midpoint through a resistor 28. Resistors 27 and 28 have small resistance and are included in the circuit merely to suppress parasitic oscillations.

Condensers 25 and 30 are radio frequency and video frequency bypass condensers, respectively. A voltage source such as a battery 31 supplies anode voltage to the tube 22 through a conductor 32 and anode voltage to the tube 21 through a coupling resistor 34. It also supplies screen grid voltage to the power amplifier tubes 13 and 14 through resistors 36 and 37. The capacitor 38 across battery 31 may be provided for bypassing the video and synchronizing pulse frequencies.

A capacitor 41 connected between the cathode of tube 22 and the cathode of the diode 26 is an important element of my improved circuit because its voltage is added in series to the voltage of source 31 in response to the occurrence of a synchronizing pulse, and this increased voltage is applied to the screen grids and anodes of the power amplifier tubes 13 and 14. This action will be understood by following through the circuit operation as follows: The synchronizing pulses are applied with negative polarity to the grid of the tube 21. Between pulses, therefore, this grid is at about cathode potential and the potential at the anode of the tube 21 is at about its minimum value. This minimum voltage applied to the control grid of tube 22 biases the tube close to plate current cut-off since its cathode is above ground potential and positive with respect to the control grid due to plate current flow (even though a small amount) through the cathode resistor 23.

Thus, between synchronizing pulses the anode-cathode impedance of tube 22 is high and the capacitor 41 is charged substantially to the voltage of the plate supply 31. This charge is acquired through a path that may be traced from the positive terminal of battery 31 through resistor 27, diode 26 and a conductor 42 to one side of capacitor 41, and from the other side of capacitor 41 through cathode resistor 23 to ground and to the negative terminal of source 31.

Upon the occurrence of a synchronizing pulse, the anode-cathode impedance of tube 22 is reduced to a comparatively low value whereby the tube 22 functions as a switch to connect the lower or negative side of capacitor 41 to the positive terminal of the battery 31. Since the capacitor 41 is of large capacity, any charge lost during the application of a synchronizing pulse does not lower the voltage thereacross very much. The result of the above switching action is that there is applied to the cathode of diode 26 and to the anodes and screen grids of power amplifier tubes 13 and 14 a voltage that is, in an ideal circuit, double the voltage of source 31. This increased voltage at the positive side of capacitor 41 is impressed upon the power amplifier anodes through resistor 28 and the inductor of tuned circuit 12. It is impressed upon the power amplifier screen grids through a coupling capacitor 46 and the resistor 37. Consequently, the power output of tubes 13 and 14 is increased upon the occurrence of synchronizing pulses, i. e. the carrier wave is amplitude modulated by these pulses. This momentary additional power is actually obtained from the large capacitor 41 which is storing energy between pulses.

It will be evident that the diode 26 is non-conducting during the application of a synchronizing pulse since its cathode is driven beyond the positive potential of the diode plate. Therefore, the diode 26 provides the necessary impedance in the power amplifier plate circuit for plate modulation. Between synchronizing pulses, and during grid modulation by the picture signal, however, the diode 26 is conducting whereby the impedance of the power amplifier plate circuit is very low. It follows that any undesirable degenerative effect during the picture modulation intervals is avoided. In the particular example illustrated, the power amplifier tubes 13 and 14 are screen grid tubes but it should be understood that they may be triodes if properly neutralized.

Fig. 2 illustrates an embodiment of the invention in which a triode 51 is substituted for the cathode resistor 23 of Fig. 1. Synchronizing pulses are applied with negative polarity to the grid of tube 51 from a cathode resistor 52 of the amplifier tube 21. It will be evident that the operation of this embodiment is the same as previously described, the difference being that in Fig. 1 the cathode resistor 23 is effectively in shunt to the battery 31 during the application of a synchronizing pulse and will draw some current whereas in Fig. 2 the tube 51 has high anode-cathode impedance during this time and draws little, if any, battery current. Because of this, the circuit of Fig. 2 may be preferred when the voltage supply source 31 is a battery and it is important to keep the current drain to a minimum.

It should be understood that the invention is not limited to the particular circuits illustrated. For example, the D.-C. connection between the tubes 21 and 22 in Fig. 1 may be replaced by A.-C. coupling. On the drawing the values of certain circuit elements have been indicated, merely by way of example, in ohms, microfarads, and micro-microfarads.

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 cathode, a control grid and a third electrode, a source of picture signals and synchronizing signals, means for applying said picture signals to said grid to amplitude modulate said carrier wave by picture signals, and means for applying said synchronizing signals to said third electrode to amplitude modulate said carrier wave by synchronizing signals, said last means including a unilateral conducting device and means for so connecting it as to provide external impedance for said third electrode in response to and for the duration of each synchronizing signal and to provide a comparatively small external impedance therefor during the occurrence of picture signals.

2. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a cathode, a control grid and a plate, a source of picture signals and synchronizing signals, means for applying said picture signals to said grid to amplitude modulate said carrier wave by picture signals, and means for applying said synchronizing signals to said plate to amplitude modulate said carrier wave by synchronizing signals, said last means including a unilateral conducting device and means for so connecting it as to provide external plate impedance for said amplifier in response to and for the duration of each synchronizing signal and to provide a comparative-

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ly small external plate impedance therefor during the occurrence of picture signals.

3. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a cathode, a control grid and a third electrode, a source of picture signals and synchronizing signals, means for applying said picture signals to said grid to amplitude modulate said carrier wave by picture signals, and means for applying said synchronizing signals to said third electrode to amplitude modulate said carrier wave by synchronizing signals, said last means including a diode and means for so connecting it as to provide external impedance for said third electrode in response to and for the duration of each synchronizing signal and to provide a comparatively small external impedance therefor during the occurrence of picture signals.

4. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a cathode, a control grid and a third electrode, a source of picture signals and synchronizing signals, means for applying said picture signals to said grid to amplitude modulate said carrier wave by picture signals, and means for applying said synchronizing signals to said third electrode to amplitude modulate said carrier wave by synchronizing signals, said last means including a source of positive potential for said third electrode, a unilateral conducting device connected between said source and said third electrode in

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a direction to conduct current to said electrode, a capacitor and switching means connected in series with each other, said series combination being connected across said device.

5. In a television transmitter, means for producing a carrier wave, an amplifier connected to amplify said carrier wave, said amplifier having a cathode, a control grid and a third electrode, a source of picture signals and synchronizing signals, means for applying said picture signals to said grid to amplitude modulate said carrier wave by picture signals, and means for applying said synchronizing signals to said third electrode to amplitude modulate said carrier wave by synchronizing signals, said last means including a source of positive potential for said third electrode, a unilateral conducting device connected between said source and said third electrode in a direction to conduct current to said electrode, a capacitor and an electric discharge tube connected in series with each other, said electric discharge tube having a control electrode, said series combination being connected across said device whereby said electric discharge tube connects the voltage appearing across said capacitor in series-aiding relation with said source of potential in response to the application of said synchronizing pulses to said control electrode with positive polarity to increase the positive potential on said third electrode of the amplifier tube during the occurrence of a synchronizing pulse.

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