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SIGNAL-TRANSLATING CHANNEL

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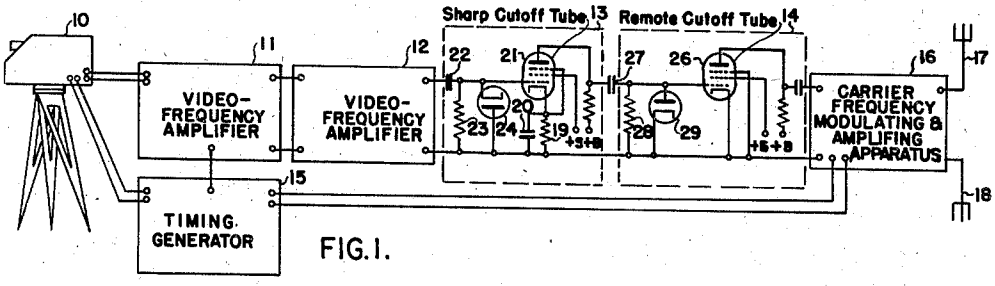


FIG. 1.

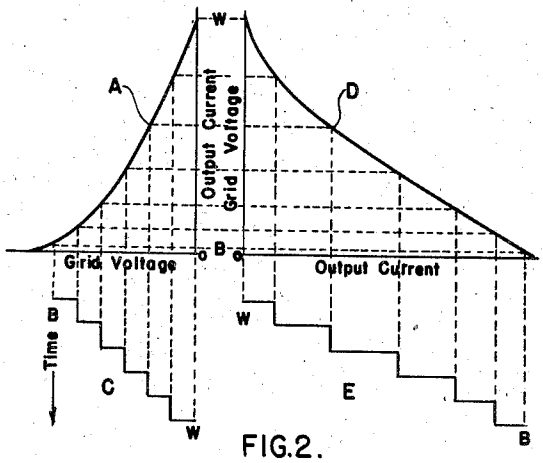


FIG. 2.

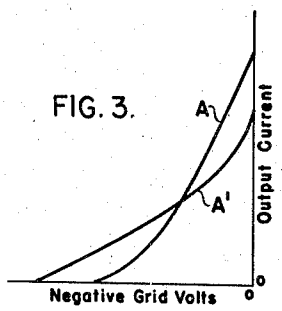


FIG. 3.

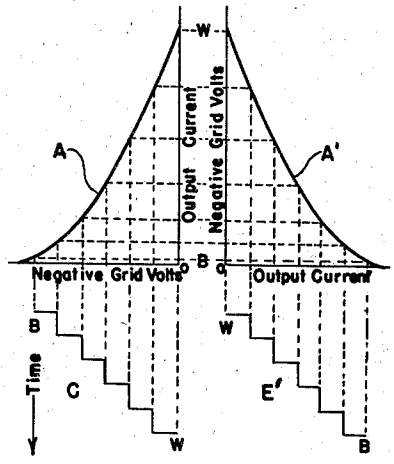


FIG. 4.

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SIGNAL-TRANSLATING CHANNEL

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8 Claims. (Cl. 178—7.1)

This invention relates to signal-translating channels comprising a plurality of stages each having a vacuum tube adapted to be operated over a wide input-amplitude range of signals and adapted to translate the signals with substantially no distortion.

It is customary to operate vacuum-tube amplifiers only over the most linear portion of their input voltage-output current characteristic in order to obtain as distortionless transmission of the translated signal as possible. However, in order to make the most economical use of a given tube, it is desirable to operate the tube over as wide a portion of its characteristic as possible. It is well known that, if a tube is operated over a nonlinear portion of its characteristic, a distortion of the reproduced signal will generally occur. Various arrangements have been proposed for compensating such distortion but such arrangements do not provide satisfactory operating conditions in some circumstances or, if satisfactory operating conditions are provided, may involve expensive or complicated additional apparatus.

It has been observed in many television receivers, which usually comprise a large number of conventional amplifier stages coupled in cascade in the signal-translating channel, that there results a crushing or amplitude compression of both black and white shades in the reproduced picture while there results a corresponding amplitude expansion of intermediate shade values. This, in general, is an undesirable result and is usually produced because of operation of the tubes over a substantial nonlinear portion of their characteristic in the region of cutoff. Since the translated signal is usually applied to successive tubes with opposite polarities, the limiting portions of the signal-amplitude range are alternately subjected to distortions which may be small in any one tube, but which are cumulative throughout the signal-translating channel, thereby producing the undesired result mentioned above.

It is an object of the invention, therefore, to provide a novel signal-translating channel in which one or more of the above-mentioned disadvantages is eliminated.

It is another object of the invention to provide a novel signal-translating channel utilizing only conventional vacuum tubes operating over wide portions of their signal-input amplitude ranges and yet eliminating all of the above-mentioned disadvantages.

In accordance with the invention, a signal-translating channel comprises a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion of the characteristic. The channel includes also a second repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation, the characteristic of which is geometrically similar over its range to that of the tube of the first-mentioned stage when plotted with interchanged co-ordinates. The two stages are coupled in cascade in the signal-translating channel, and there is provided means for applying the signal translated by said channel to the stages so that corresponding portions of the amplitude range of the signal fall on geometrically corresponding portions of the respective characteristics with opposite polarities, whereby signals translated through the channel are substantially undistorted by translation through the stages.

In accordance with a preferred embodiment of the invention, a stage comprising a conventional vacuum tube having a sharp cutoff characteristic is paired with a stage utilizing a tube of the remote cutoff type in order to provide the desired compensation as between the two stages.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a circuit diagram, partly schematic, of certain essentials of a television transmitting system embodying the present invention; Fig. 2 is a graph illustrating certain of the disadvantages present in conventional arrangements of the prior art utilizing similar vacuum tubes in successive stages; while Figs. 3 and 4 are graphs utilized to explain the operation of the present invention.

Referring now more particularly to Fig. 1 of the drawing, there is shown a schematic circuit diagram of a television transmitting system comprising a camera or signal generator 10 which may include the usual cathode-ray signal-generating tube and scanning and wave-shaping apparatus. Connected in cascade to the output circuit of signal generator 10, in the order named, are video-frequency amplifiers 11, 12, 13, and 14, a carrier-frequency modulating and amplifying apparatus 15, and a radiating antenna system

17, 18, the general arrangement and the units shown schematically being in accordance with conventional practice. A timing generator 15 is provided which may comprise field-frequency and line-frequency synchronizing-signal generators and blanking or pedestal generators also in accordance with conventional practice.

For the purpose of providing distortionless transmission, as between amplifier stages 13 and 14 of the transmitter of Fig. 1, there is included in stage 13 a vacuum-tube amplifier 21 which may be of the conventional sharp cutoff type. The signal input to tube 21 is stabilized at a predetermined shade level of the transmitted signal by means of a series coupling condenser 22 and a shunt load resistor 23 across which is coupled a direct current reinserting or stabilizing diode 24. A suitable bias is provided by resistor 19 shunted by condenser 20 for high-frequency signals, in order properly to relate the stabilized signal to the input voltage-output current characteristic of tube 21. Stage 14 of the transmitter comprises a vacuum-tube amplifier 26 which may be of the variable-mu or remote cutoff type. In order to stabilize the translated signal for operation over a predetermined portion of the characteristic of amplifier 26, there is provided a series coupling condenser 27 and a shunt load resistor 28 across which is connected a diode 29 adapted to provide direct current reinsertion or stabilization.

Neglecting for the moment the details of operation of the present invention, the system just described comprises the essential elements of a television transmitting system of conventional construction rendering a detailed description of the general system and its operation unnecessary. Briefly, however, the scene to be transmitted is focused on the target in the signal generator 10 and a video-frequency voltage is developed thereby in the usual manner and is applied to the video-frequency amplifier 11 wherein this voltage is amplified and from which it is transmitted through amplifiers 12, 13, and 14 to the carrier-frequency modulating and amplifying unit 16. Synchronizing signals are provided by timing generator 15 for the scanning apparatus of signal generator 10 as well as conventional blanking or pedestal pulses which are applied to video-frequency amplifier 11, while synchronizing signals for modulating the carrier signal are applied to carrier-frequency modulating and amplifying unit 16, all in a conventional manner.

Reference is now made to Fig. 2 in order to explain a defect which is inherent in signal-translating channels utilizing similar tubes of conventional design and operated over a curved portion of their input voltage-output current characteristics. Curve A of Fig. 2 represents such a conventional characteristic and it will be assumed for the purposes of explanation that there is applied to the input electrodes of the tube a television signal voltage representing uniformly stepped shade values as shown by curve C, on which point B represents the signal-amplitude level corresponding to black in the transmitted image, while the point W represents the white level. In conventional signal-translating channels, the output from a tube having the characteristic of curve A is applied with reversed polarity to the input electrodes of the succeeding tube which usually has an identical or similar grid voltage-output current characteristic. An identical characteristic for such a tube, to which the output from the tube having the characteristic of curve A is applied with reversed polarity, is represented by curve D of the drawing, while curve E represents the output signal from the tube having the characteristics D, the co-ordinates of curve D being interchanged with respect to those of curve A for convenience of plotting. The amplitude levels of the translated signals corresponding to black and white are indicated by the points B and W, respectively, throughout the path of the translated signals. It is thus seen that the signal C, representing uniformly stepped shade values, has been amplified and distorted in such manner that both the white and black shades of the signal have been crushed or compressed with reference to the intermediate shade values. This is an effect which is readily noticeable in many television signal-translating apparatus.

Reference is made to the curves of Figs. 3 and 4 for an explanation of the application of the present invention to this problem. In Fig. 3, curve A represents a characteristic which is identical with characteristic A of Fig. 2. Curve A' represents the characteristic of a tube which, it has been discovered, is effective exactly to compensate for the distortion produced in a tube having the characteristic A when operated over the nonlinear portion of its characteristic. As stated above, curve A is substantially the characteristic provided by a conventional vacuum tube of the sharp cutoff type, while curve A' is a characteristic which is typical of that provided by a commercial tube of the variable-mu or remote cutoff type. The criterion for distortionless transmission is that curve A shall be geometrically similar over its operating range to curve A' when plotted with interchanged coordinates. This is more clearly illustrated in Fig. 4 wherein curve A is identical with that of curve A of Fig. 3 and curve A' has been plotted adjacent curve A but with interchanged coordinates. Under these conditions, it is seen that curve A is geometrically similar to curve A' over the operating range of the applied signal. For the purposes of illustration, it is again assumed that a signal represented by curve C is applied to the input circuit of the tube having the characteristic A of Fig. 4 and that the output of this tube is coupled with reversed polarity to the input circuit of the tube having the characteristic A', the signals being stabilized at the input electrodes of the two tubes to operate the two tubes over substantial portions of their respective characteristics. Under these conditions, it is seen that the signal output E' of the tube having the characteristic A' is undistorted with respect to the signal input C.

Referring now more particularly to the operation of the system of Fig. 1, it will be assumed that the signal output of video-frequency amplifier 12 is poled with the amplitude level thereof corresponding to black negative; that the signal is stabilized at such black level by means of diode reinserter 24 and its load resistor 23; and that the necessary bias is developed across resistor 19. Tube 21 may have the characteristic of curve A of Fig. 4 and, for the purposes of illustration, the input signal thereto may be that of curve C of Fig. 4. Tube 21 is thus so biased as to be operated over a predetermined portion of its grid voltage-output current characteristic including a substantial nonlinear portion in the anode current cutoff region with the level corresponding to black stabilized at the limit of this nonlinear portion. This signal is amplified in

the usual manner by means of amplifier 21 and is applied to the input electrodes of vacuum-tube amplifier 26. Vacuum-tube amplifier 26, being a tube of the remote cutoff type, has a grid voltage-output current characteristic over a predetermined range of operation and including a more remote cutoff point than that of tube 21, substantially as shown by curve A' of Figs. 3 and 4. This curve A' is geometrically similar to curve A of tube 21 when plotted on interchanged coordinates and the signal input to tube 26 is poled with the amplitude level corresponding to white negative and the translated signal is, therefore, applied to amplifier 26 with a polarity opposite to that of the signal applied to amplifier 21. Diode reinserter 29 together with its load resistor 28 is effective to stabilize the signal for operation over the indicated portion of the curve A'. Therefore, since the stages 13 and 14 are coupled in cascade in the signal-translating channel, corresponding portions of the amplitude range of the signal input to amplifier 26 fall on portions of the characteristic A' geometrically corresponding to the portions of characteristic A on which fall corresponding portions of the amplitude range of the signal input to amplifier 21 but with opposite polarity. Signals translated through the channels are, therefore, as indicated by curve E', substantially undistorted with respect to the signal input E by translation through the two stages 13 and 14. Video-frequency stages 11 and 12 may be of a conventional type or may correspond respectively to stages 13 and 14. While the invention has been described with reference to a television signal transmitter, it will be understood that the invention is also applicable to any type of signal-translating channel and is particularly useful in the signal-translating channel of a television receiver. It has been found that, by utilizing tubes of the sharp cutoff type in alternate signal-translating stages of a television receiver and utilizing tubes of the remote cutoff type in the remaining signal-translating stages of the receiver, the above-mentioned effect of crushing of black and white shade components in the translated picture is substantially eliminated. That is, it has been found to be expedient in television signal-translating apparatus to provide a video-frequency signal-translating channel comprising a first group of repeater stages, similar to stage 13, including vacuum tubes having grid voltage-output current characteristics over predetermined ranges of operation including substantially nonlinear portions, and to provide a second and substantially equal group of repeater stages, similar to stage 14, including vacuum tubes having given grid voltage-output current characteristics over predetermined ranges of operation which are geometrically similar, respectively, to those of tubes of the first group when plotted with interchanged coordinates. In such an arrangement, the stages are coupled in cascade in the signal-translating channel and means are provided for applying the signal translated by the channel to the stages so that corresponding portions of the amplitude range of the translated signal fall on geometrically corresponding portions of their respective characteristics and with opposite polarities as between the first and second groups of stages. By this arrangement, signals translated through the channel are substantially undistorted by translation through the channel.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A signal-translating channel comprising, a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion, a second repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

2. A signal-translating channel comprising, a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion in the anode-current cutoff region of the characteristic, a second repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

3. A signal-translating channel comprising, a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion in the anode-current cutoff region of the characteristic, a second repeater stage including a vacuum tube having a more remote anode-current cutoff point than said first tube and a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

4. A signal-translating channel comprising, a first repeater stage including a vacuum tube of the sharp cutoff type having a given grid volt-

age-output current characteristic over a predetermined range of operation including a substantial nonlinear portion nearer its cutoff region, a second repeater stage including a vacuum tube of the remote cutoff type having a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

5. In a television signal-translating apparatus, a signal-translating channel comprising, a first group of repeater stages including vacuum tubes having given grid voltage-output current characteristics over predetermined ranges of operation including substantial nonlinear portions, a second and substantially equal group of repeater stages including vacuum tubes having given grid voltage-output current characteristics over predetermined ranges of operation which are geometrically similar, respectively, to those of tubes of said first group when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics and with opposite polarities as between said first and second groups of stages, whereby signals translated through said channel are substantially undistorted by translation through said stages.

6. In a television signal-translating apparatus, a signal-translating channel comprising, a first group of repeater stages including vacuum tubes of the sharp cutoff type having given grid voltage-output current characteristics including substantial nonlinear portions over predetermined ranges of operation, a second and substantially equal group of repeater stages including vacuum tubes of the remote cutoff type having grid voltage-output current characteristics over predetermined ranges of operations geometrically similar, respectively, to those of tubes of said first group when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics and with opposite polarities as between the tubes of said two groups, whereby signals translated through said channel are substantially undistorted by translation through said stages.

7. In a television signal-translating system, a video-frequency signal-translating channel comprising, a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion, a second repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means including signal-stabilizing means for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

8. In a television signal-translating system, a video-frequency signal-translating channel comprising, a first repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation including a substantial nonlinear portion, a second repeater stage including a vacuum tube having a given grid voltage-output current characteristic over a predetermined range of operation geometrically similar to that of said tube of said first stage when plotted with interchanged co-ordinates, said stages being coupled in cascade in said channel, and means including signal-stabilizing means for stabilizing the black level of said signal at that limit of the range of said first stage which is also the limit of said nonlinear portion and for applying the signal translated by said channel to said stages so that corresponding portions of the amplitude range of said signal fall on geometrically corresponding portions of their respective characteristics with opposite polarities, whereby signals translated through said channel are substantially undistorted by translation through said stages.

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