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TELEVISION SYSTEM

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Fig. 1

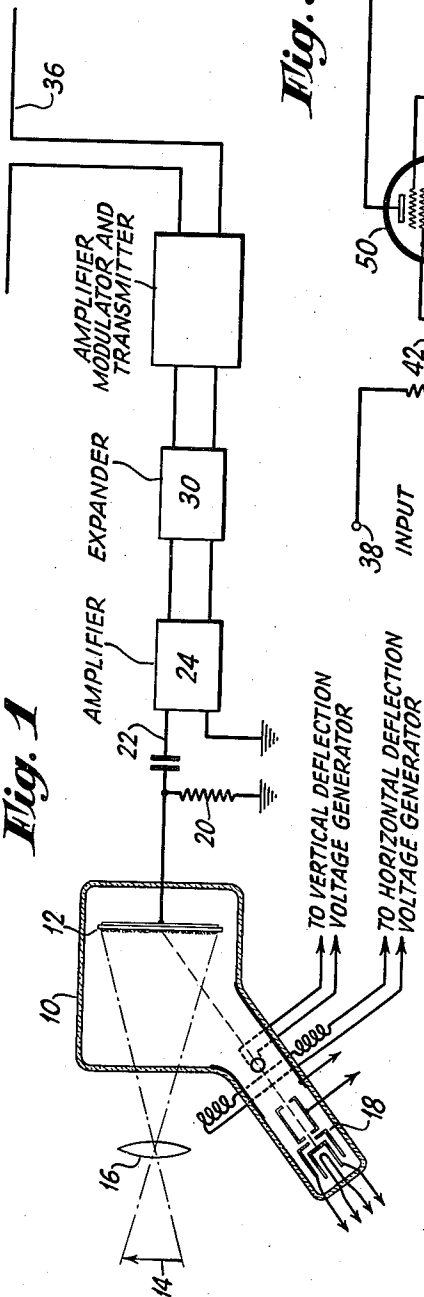


Fig. 3

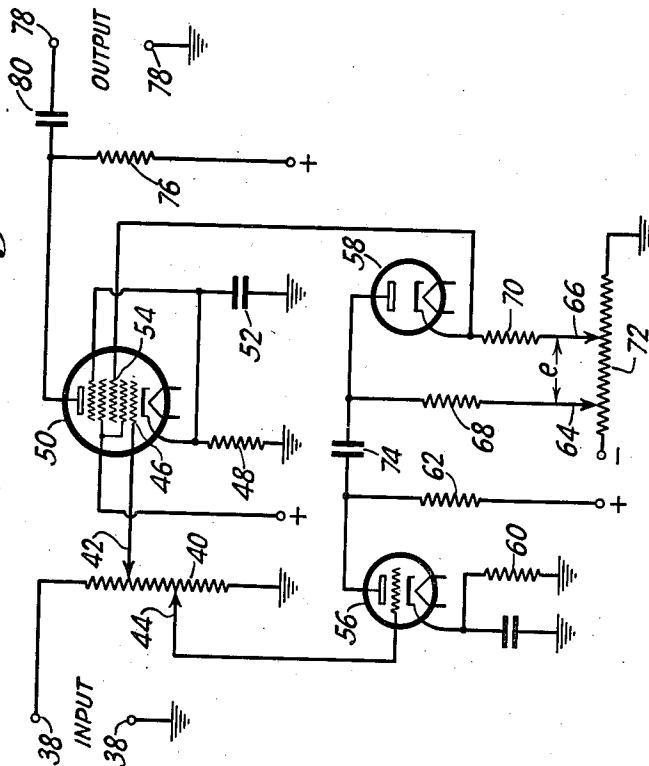
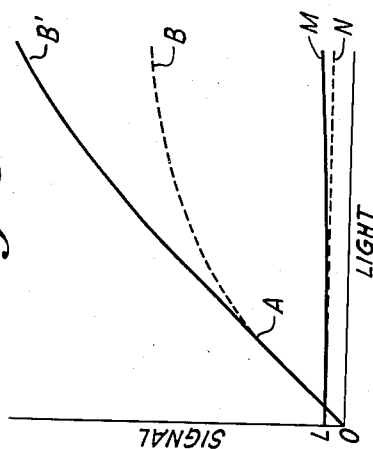


Fig. 2



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TELEVISION SYSTEM

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2 Claims. (Cl. 178-7.2)

The present invention relates to an improvement in a television transmitting system and particularly the manner in which the signals derived from the television transmitting tube are amplified prior to their being modulated and transmitted.

In television transmitting systems a transmitting tube is provided which primarily performs the function of converting a light image into a series of signals representative thereof, the series of signals being conventionally called video signals. These signals are, of course, relatively small in magnitude or intensity and considerable amplification of the signals is necessary before they may be used to control the modulation of the television carrier frequency. The carrier frequency as modulated by the video signals is then transmitted and is ultimately received at a receiving station where the receiving apparatus utilizes the detected video signals to reconstruct an image of the picture transmitted.

The fidelity of the picture constructed at the receiver depends upon the operating characteristics of the various elements of both the transmitter and the receiver, and it is of course desirable that each element of the system operate in a manner such that true over-all fidelity is possible. For such operation, the strength of the video signals should be directly proportional to or should bear a definite and constant relationship to the light intensity of the image brought to focus upon the light sensitive electrode of the television transmitting tube.

It has been found, however, that some television transmitting tubes per se do not strictly comply with these requirements since the relationship between the signal output of the television transmitting tube and the light intensity projected on the light responsive electrode thereof is not specifically linear.

It is therefore one purpose of the present invention to provide a means whereby the signal output from a television transmitting tube may be so amplified that the amplified signal may bear the proper relationship to the light intensity of the image to be transmitted.

A further purpose of the present invention resides in the provision of means whereby certain signal strengths may be amplified to a greater or lesser extent than other signal strengths in order that the over-all operating characteristics of the television transmitting tube and the amplifiers approach or acquire the linear relationship that is desirable.

Other purposes and advantages of the present invention will become more apparent to those skilled in the art from a reading of the following specification and claims, particularly when considered in connection with the drawing wherein:

Figure 1 shows schematically a television transmitting tube and the associated circuit elements;

Figure 2 shows one form of an amplifying system, and

Figure 3 shows a set of curves representing the operating characteristics of a television system when operated in accordance with the present invention.

Referring now to the drawing, and particularly to Figure 1, a television transmitting tube 10 is shown, which includes a light sensitive electrode 12 upon which an image of an object 14 may be brought to focus through the use of an appropriate lens system 16. The electrode 12 may, for example, be composed of a plurality of elemental photoelectric elements electrically insulated from each other so that each element may operate as an individual photoelectric cell and will respond to the intensity of the light projected thereupon. For converting the charge image or the electrical image present upon the light responsive electrode into a series of video signals a cathode ray generating means is provided. The cathode ray gun is shown at 18, and the cathode ray produced thereby is projected toward the electrode 12 and is caused to be deflected in two substantially normal directions in order that the light responsive electrode may be scanned in a systematic manner. The deflecting means for the cathode ray beam may be electrostatic plates or it may be electromagnetic coils or a combination of these two means, neither of which is shown.

When a light image is brought to focus upon the light responsive electrode 12 and the surface of the electrode is scanned by the cathode ray beam produced by the gun structure 18, a series of video signals may be derived from the signal plate of the electrode 12 and these signals are impressed upon a load resistance 20. The varying intensity of the signals of course produces varying voltage drops along the load resistance 20 so that the potential of conductor 22 varies in accordance with the strength of the video signals and also in accordance with the light intensity projected upon the light responsive electrode. For increasing the intensity or strength of these video signals an amplifier 24 is provided which may be a conventional broad band am-

plifier capable of handling the frequencies present in a video signal series.

In Figure 3 is shown the characteristics of certain television transmitting tubes wherein the strength of signal is shown with respect to the intensity of light projected on the light responsive electrode thereof. Up to a light value of A the signal output of the television transmitting tube remains more or less linear but when the light value is increased from the value A to the value B, the signal output of the tube does not continue linearly but follows somewhat in the manner represented by the curve OAB.

It would be highly desirable to have the output characteristics of the television transmitting tube bear a more linear relationship between the signal output and the light projected upon the light responsive electrode, and in order to produce such a characteristic it would be necessary to increase the intensity of the signals during those periods when higher light intensities are projected upon the electrode 12. Such a linear or substantially linear condition may be produced by amplifying the signals produced under more intense light conditions by larger amounts than the signals produced under the lower light values. For performing this function, the characteristics of an "expander" have been found to be desirable, since an expander amplifier does not respond in a linear manner but instead amplifies signals of higher intensity to a greater degree than low intensity signals.

When an expander is applied to the video signals as derived from the amplifier 24, the expander being so adjusted and having the characteristics that it becomes effective for all signal values above a value corresponding to the light value A, the characteristics of the system, including the transmitting tube 10, the amplifier 24 and the expander 30, follows a curve such as OAB' rather than the curve OAB. It may be seen, therefore, that the relationship between the signal output of the expander 30 and the light projected upon the light responsive electrode 12 becomes more linear with the result that the fidelity of the signals after having been expanded is materially increased over unexpanded signals.

The signals, after being expanded by an amount sufficient to produce operating characteristics such as that shown by the curve OAB', are then further amplified and used to modulate the carrier frequency, the modulated carrier being then applied to the television transmitting aerial 36.

It is true that, while the expander is increasing the amplification of certain signals lying within the region corresponding to the light values from A to B, the signal noise is also amplified by a like percentage as represented by the curve LM over the usual noise curve LN. Even though the noise is amplified by a certain percentage, the ratio of noise to video signal remains constant so that no disadvantages arise from this standpoint.

In Figure 2 is shown an example of an amplifier circuit or expander circuit which may be used as explained above in order to improve the signal level of the video signals, particularly in the region corresponding to high light values. Signal energy from the amplifier 24 (shown schematically in Figure 1) may be applied to the input terminals 38, across which is connected a resistance 40. Associated with the resistance are a pair of slideably adjustable contacts 42 and 44. The contact 42 is connected to the control elec-

trode 46 of a multi-grid discharge tube 50. The cathode of the tube 50 is connected to the control electrode 46 of a multi-grid discharge tube 50. The cathode of the tube 50 is connected to ground by way of a resistance 48 in order that an appropriate grid bias may be maintained upon the tube, and the resistance 48 is bypassed by an appropriate condenser 52. The tube 50 may correspond to a conventional pentagrid mixer and #2 and #4 grids, which are connected together within the tube, are supplied with a positive source of potential. The suppressor grid or #5 grid is connected to the cathode of the tube. It is well known that the potential which is applied to the #3 grid (which is conventionally called the "oscillator grid" affects and in part determines the gain of the tube. If the potential of grid 54, that is, the #3 grid, is maintained at a constant potential, then the tube 50 operates at a constant gain.

In order to control the potential of the grid 54 in order to vary the characteristics of the tube 50 and alter the gain of the tube, a pair of discharge tubes 56 and 58 are provided. The tube 56 comprises a cathode, a control electrode and an anode, and the cathode is connected to ground by way of a cathode resistance 60 which is bypassed by a condenser. The control electrode of the tube 56 is supplied with signal energy from the movable contact 44, and the anode of the tube is supplied with a positive source of potential through an appropriate load resistance 62.

The discharge tube 58 functions as a rectifier and includes only an anode and a cathode. The anode of the tube 58 is normally maintained slightly negative with respect to the cathode, and this negative potential is made adjustable through the provision of adjustable contacts 64 and 66. These contacts are connected to the anode and cathode of the tube 58 by way of resistors 68 and 70 respectively. The movable contacts 64 and 66 cooperate with a potentiometer 72, one end of which is connected to ground, whereas the other end is connected to a source of negative potential. The amplified signals are impressed across the anode and cathode of the tube 58 by way of ground and the coupling condenser 74, and in view of the fact that the anode of the tube 58 is maintained negative with respect to its cathode by a voltage e as determined by the setting of the adjustable contacts 64 and 66, no current will be passed by the tube 58 until the signal energy applied thereto exceeds the voltage e . When the signals applied to the tube 58 are of a value less than the voltage e , the control electrode 54 of the tube 50 is maintained at a constant negative potential and the tube 50 operates at constant gain as determined by this negative potential. When, however, the signal energy applied to the tube 58 exceeds the voltage e , then a certain amount of current will be permitted to flow through the discharge tube 58, which current will cause a change in potential of the cathode of the tube 58. This change in potential is then applied to the #3 grid or grid 54 of the discharge tube 50 in order to alter the operating characteristics of the tube. When the signal strength is of sufficient amplitude to exceed the voltage e and to permit current to flow through the tube 58, the potential of the grid 54 is made less negative so that the amplifying characteristics of the tube 50 are increased. The anode of the tube 50 is, of course, supplied with a source of positive current by way of a load resistor 76 and the output from the am-

plifying tube 50 is impressed upon the output terminals 78 through the coupling condenser 80.

When such a system is used, it may be seen that signals which are impressed across the input resistance 40 are amplified by the discharge tube 50 in accordance with its characteristics so long as the strength of the signals remain below a predetermined value. If, however, these signals exceed this value so as to cause the signals which are applied to the tube 58 to exceed the voltage e , then the operating characteristics of the tube 50 are altered in accordance with the change in potential of the #3 grid and the tube 50 then operates in accordance with an altered characteristic in order that signals of such strength are amplified to a greater degree. The system, therefore, operates as an expander circuit to amplify strong signals by an amount in excess of the amplification of weaker signals.

The degree of expansion can be readily controlled by adjusting the position of the contact 44 along the resistance 40, and the strength of the signals at which expansion begins may be altered by varying the value of the potential e . It is desirable that this value be made adjustable in view of the fact that obviously not all television transmitting tubes have the same output characteristics. Expansion should begin to be effective at a signal strength corresponding to a light value A (see Figure 3).

It will be noticed that this expander circuit is slightly different from the expander circuits conventionally used in audio channels inasmuch as the expander circuit shown in Figure 2 operates instantaneously. In expander circuits for audio frequency use the expansion response should be delayed in order that the actual reproduced audio frequency will follow the original rendition. In television use, however, it is desirable that the expansion operate substantially instantaneously and at a rate corresponding to the picture resolution of the television system. In order that the expander circuit may operate instantaneously no time constant circuits have been included in the conductor from the discharge tube 58 to the grid electrode 54 of the tube 50.

Inasmuch as expander circuits are more or less well known in the art, a further discussion of the expander circuit shown or other expander circuits which may be used is believed to be unnecessary. The patent to John F. Dreyer, Jr., #2,077,466, of April 20, 1937, shows a typical example of an expander circuit for use with audio frequencies and a more complete description of the operation of expander circuits may be found in this patent.

From the above, it may be seen that a new method of operating a television transmitting system has been devised so that the signals transmitted by the system may bear a more definite and exact relationship to the light values projected upon the light responsive electrode of the television transmitting tube, and accordingly the signal received by the receiver and likewise the image produced thereat will bear a closer resemblance to the image brought to focus upon the light responsive electrode of the transmitting tube.

Since expanders of the type referred to above may be controlled as to the degree of expansion, and since the signal level by which the expander becomes effective may be controlled, it follows that appropriate over-all operating characteristics may be obtained for substantially any tele-

vision transmitting tube having a non-linear saturation response.

Although only one example of an expander circuit is shown in the disclosure, it is to be understood that any appropriate expander may be used which will comply with the requirements of the disclosure, and furthermore, the television system with which the expander is associated has been shown schematically, since the use of an expander to correct the over-all characteristics of a television transmitting system may be applied to substantially any television system wherein such correction is desirable or necessary.

Furthermore, it is to be understood that although a somewhat particular television transmitting tube is shown schematically in Figure 1, any television transmitting tube capable of transforming a light image into a series of television signals could replace the tube shown.

Various other modifications and alterations may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such modifications be considered within the purview of the present invention except as limited by the hereinafter appended claims.

I claim:

1. In a television transmitting system wherein a transmitting tube is provided for converting an optical light image into a series of electrical signals representative of the light values of the image and in which the response characteristics of the transmitting tube are such that signals corresponding to light values in excess of a predetermined amount are attenuated, means for amplifying said series of produced electrical signals including an electron discharge tube having a cathode, a first control electrode, a second control electrode and an anode, a resistance for connecting the cathode to a point of fixed potential, means including a load resistance for maintaining the anode positive with respect to the cathode and with respect to the point of fixed potential, means for applying the series of produced electrical signals between the first control electrode and the point of fixed potential, means including an electronic device connected to said second control electrode for varying the potential of said second control electrode with respect to the point of fixed potential in response to the signal strength of the series of produced electrical signals to increase the gain of the electron discharge amplifying tube when the intensity of electrical signals representing light values is in excess of the said predetermined amount in proportion to their intensity, whereby the over-all characteristics of the transmitting tube and the amplifier will be such that a substantially direct relationship exists between the strength of the signals and the value of light projected on the light responsive electrode of the tube.

2. In a television transmitting system including a transmitting tube for transforming an optical light image into a series of electrical signals representative of the light values of the image and wherein the characteristics of the transmitting tube are such that a non-linear condition normally exists between the intensity of the electrical signals and the value of the light projected on the light responsive electrode of the tube for light values in excess of a predetermined amount, means for amplifying the series of signals, including an electron discharge tube having a cathode, a first control electrode, a second control electrode and an anode, a resistance for connecting

the cathode to a point of fixed potential, means including a load resistance for maintaining the anode positive with respect to the cathode and with respect to the point of fixed potential, means for applying the series of produced electrical signals between the first control electrode and the point of fixed potential, means including an electronic device connected to said second control electrode for varying the potential of said second control electrode with respect to the point of fixed potential in response to the signal strength of the series of produced electrical signals to increase the gain of the electron discharge amplifying tube when the intensity of the electrical signals representing light values is in excess of the said predetermined amount only, whereby signals corresponding to light values in excess of the said predetermined amount are amplified by an amount greater than the amount by which signals corresponding to light values below the said predetermined amount are amplified to result in a substantially linear relationship between the amplified electrical signals and the light values of the image.

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