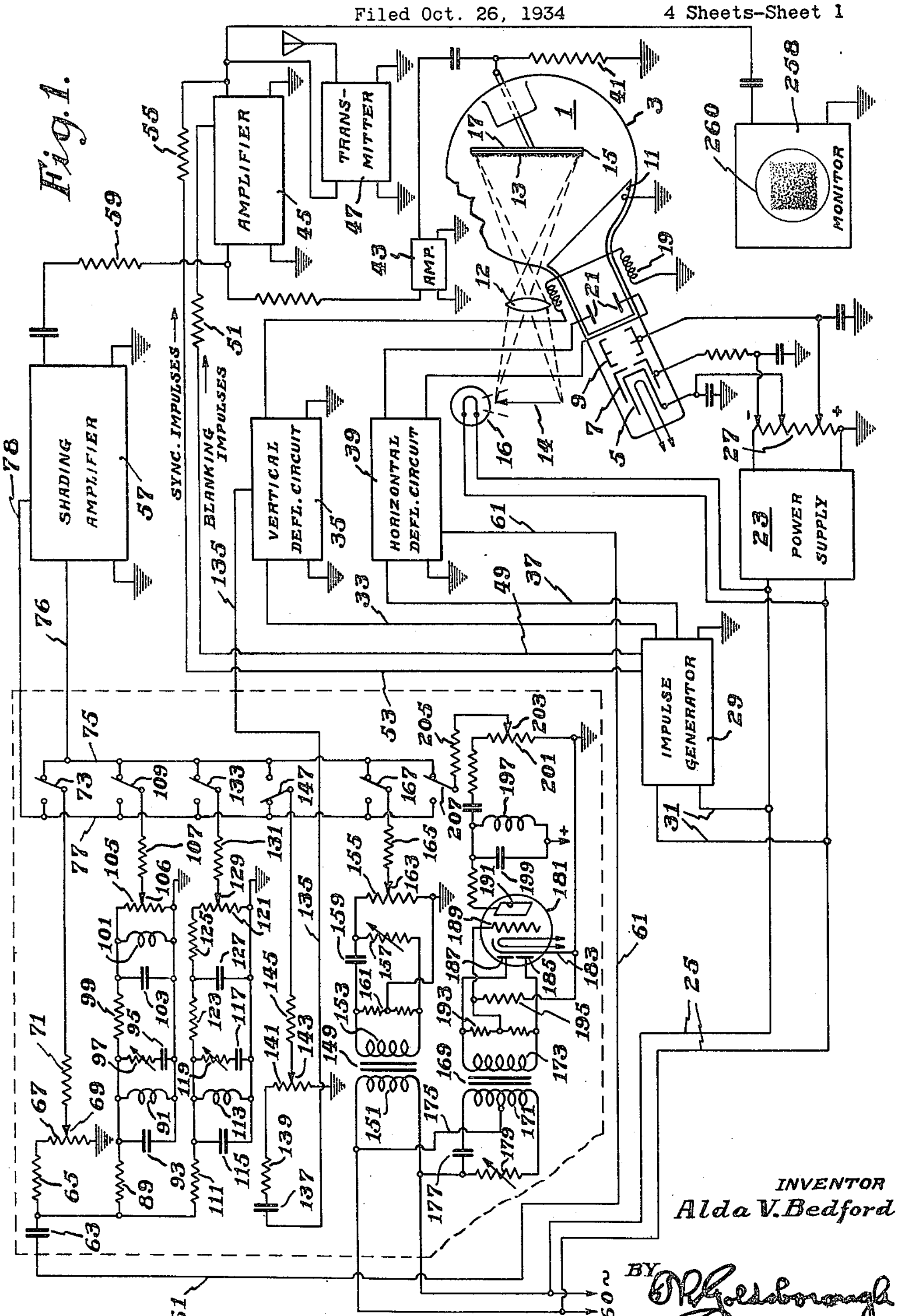
July 18, 1939. A. V. BEDFORD 2,166,712

TELEVISION SYSTEM

Filed Oct. 26, 1934 4 Sheets-Sheet 1



INVENTOR
Alda V. Bedford
BY
ATTORNEY

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TELEVISION SYSTEM

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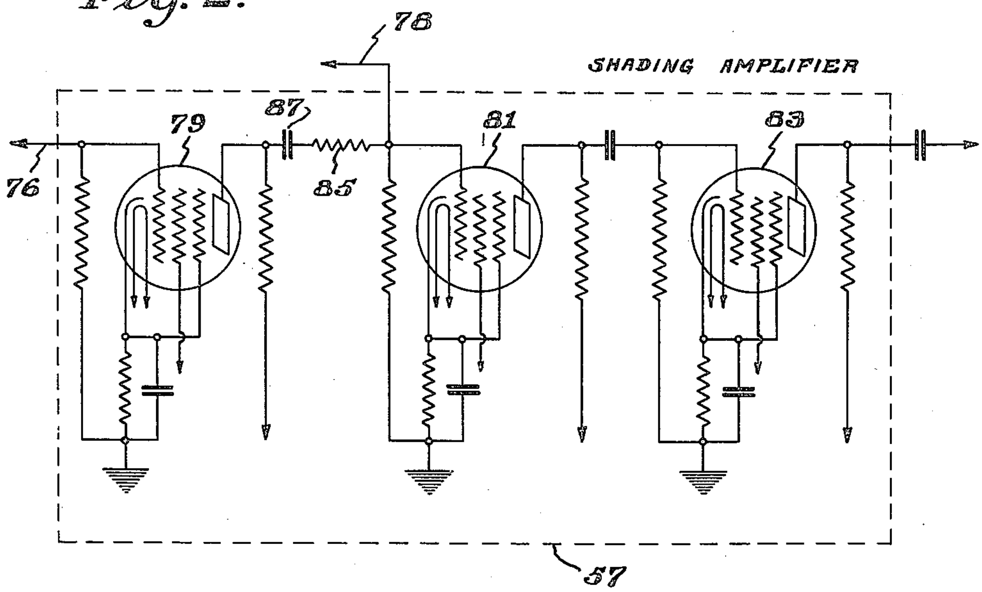
Fig. 2.



INVENTOR
Alda V. Bedford
BY R. Goldsborough
ATTORNEY

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Fig. 3.

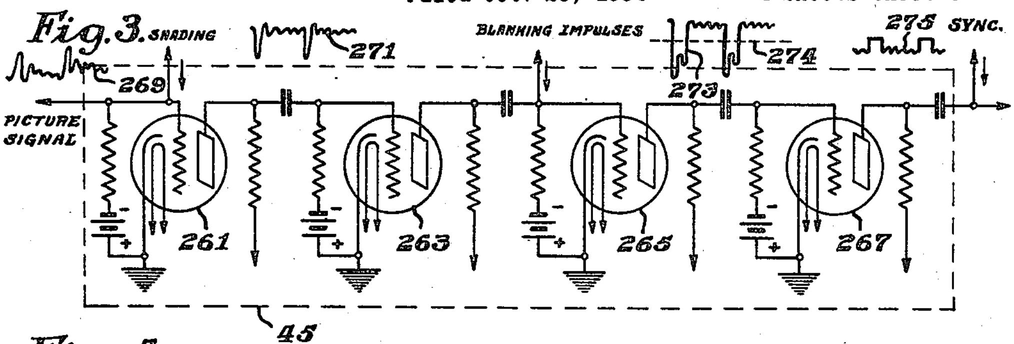


Fig. 4.

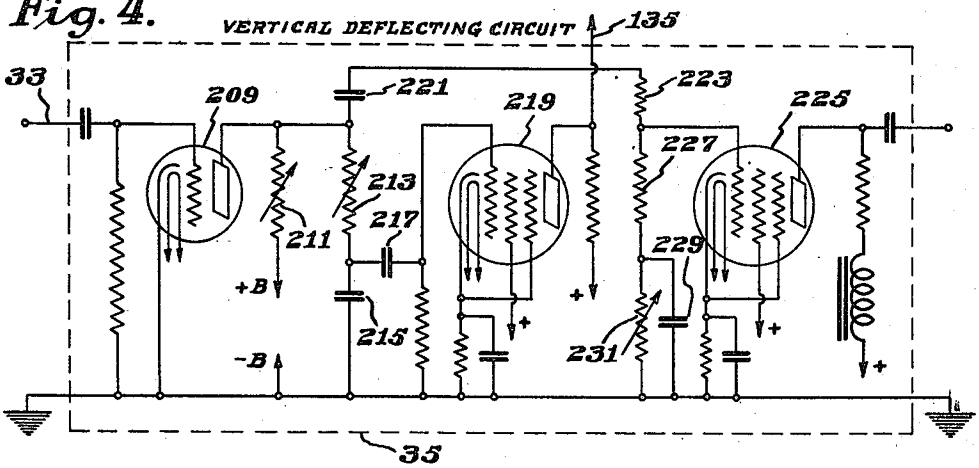
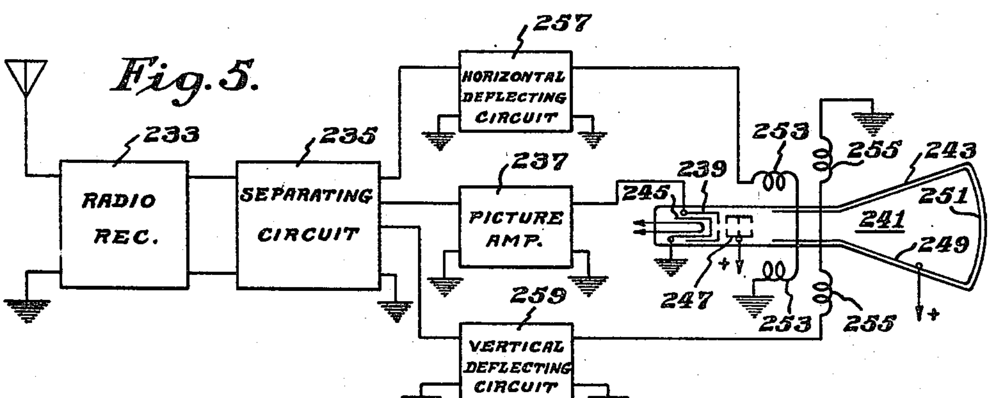


Fig. 5.



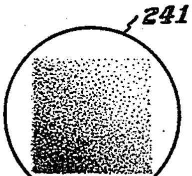


Fig. 6.

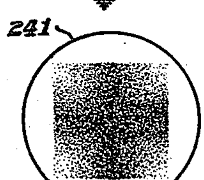


Fig. 7.

INVENTOR
Alda V. Bedford

BY T. R. Goldsborough

ATTORNEY

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Fig. 8.

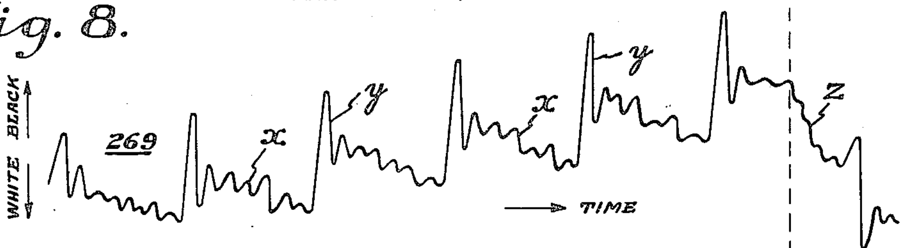


Fig. 9.

Fig. 10.

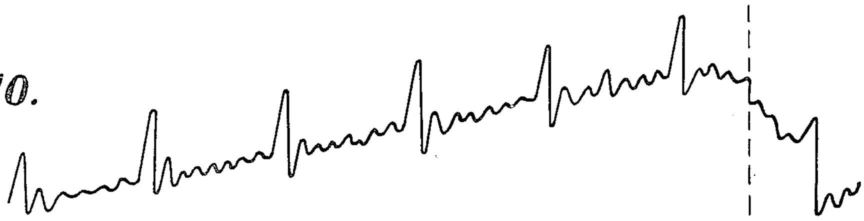
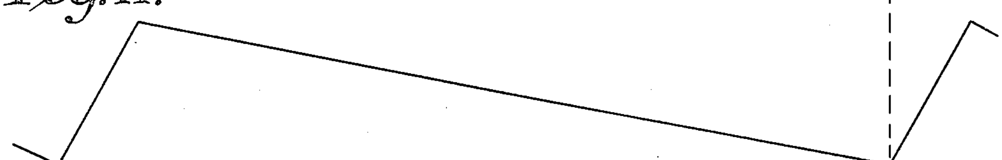


Fig. 11.



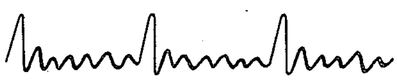


Fig. 12.

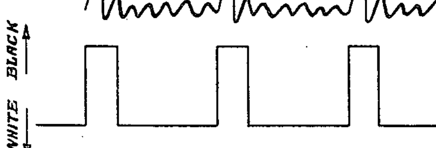


Fig. 13.

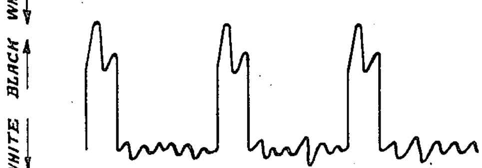


Fig. 14.

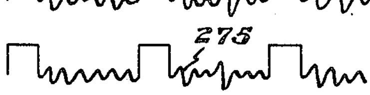


Fig. 15.

Fig. 16.

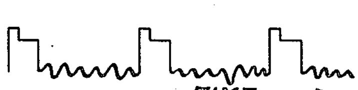


Fig. 17.

INVENTOR
Alda V. Bedford
BY [signature]
ATTORNEY

Patented July 18, 1939

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UNITED STATES PATENT OFFICE

2,166,712

TELEVISION SYSTEM

Alda V. Bedford, Collingswood, N. J., assignor, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

Application October 26, 1934, Serial No. 750,055

18 Claims. (Cl. 178—7.2)

My invention relates to television systems and particularly to television systems of the type in which a cathode-ray transmitter tube is employed.

In television systems of the above-mentioned type it has been found that a picture appearing at the receiver usually is too dark in certain areas and too light in other areas. For example, one corner of the picture may be of a very dark shade while the corner diagonally opposite may be of a very light shade. This is commonly referred to as "black spot". An investigation has shown that this is mainly the result of a characteristic of the cathode-ray transmitter tube. In addition, however, the use of alternating current lighting for illuminating the object to be transmitted causes a hum component to be superimposed on the picture signal which causes uneven shading of the picture.

In addition to causing unequal shading of the picture, prior to my invention the above-mentioned characteristic of the transmitter tube made it difficult to eliminate transients or other undesired signals from the output thereof while obtaining maximum signal output.

It is, accordingly, an object of my invention to provide a method of and means for correcting, or otherwise controlling, the shading of a television picture.

It is a further object of my invention to provide an improved method of and an improved means for preventing the transmission of undesired signals from the picture transmitter.

In a preferred embodiment of my invention I provide means for mixing with the picture signal saw-tooth and sine waves at the horizontal deflecting frequency and harmonics thereof and saw-tooth and sine waves at the vertical deflecting frequency and harmonics thereof. I have found that by mixing such correcting waves or signals in the proper phase and amplitude with the picture signal, a signal may be sent out from the transmitter which will produce a properly shaded picture at the receiver.

Also, in a preferred embodiment, I provide a circuit including a "clipping" tube for removing undesired transients or the like from the output of the cathode-ray transmitter tube and, to facilitate their removal, I mix the above-mentioned correcting signals with the transmitter tube output at a point preceding the "clipping" tube.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a circuit and block diagram of a television transmitter embodying my invention,

Fig. 2 is a circuit diagram of the shading amplifier shown in Fig. 1,

Fig. 3 is a circuit diagram of one of the amplifiers shown in Fig. 1,

Fig. 4 is a circuit diagram of the vertical deflecting circuit shown in Fig. 1,

Fig. 5 is a schematic diagram of a television receiver,

Figs. 6 and 7 are views representing the possible shading of a picture appearing on the fluorescent screen of the cathode-ray tube receiver, and

Figs. 8 to 17 inclusive are curves which are referred to in explaining the invention.

Referring to Fig. 1, the transmitter includes a cathode-ray transmitter tube 1 of the type described in an article by V. K. Zworykin published in the January, 1934, issue of the Proceedings of the Institute of Radio Engineers. The tube comprises an evacuated envelope 3 in which there is located an electron gun consisting of an indirectly heated cathode 5, a control electrode 7 and a first anode 9. A second anode 11 consisting of a metallic coating on the inner surface of the enevelope 3 is provided for accelerating the electrons in the electron beam and for aiding in the focusing of the beam.

A mosaic 13 of light-senstive elements is so positioned inside the envelope 3 that an optical image, formed by a suitable lens system 12, may be projected thereon whereby capacity elements which are associated with elements of the mosaic are charged in accordance with the intensity of light striking them. This forms on the mosaic what may be referred to as an "electrical image". Also, the mosaic is so positioned that it may be scanned by the electron beam.

If an indoor scene is to be transmitted it will generally be desired to illuminate the scene or object, indicated at 14, by means of incandescent lamps, such as the lamp 16, which are supplied with current from the 60 cycle power line 25. While the light from such a source varies periodically in intensity whereby the light striking the mosaic 13 causes a hum component in the picture signal, this effect may be compensated for in my system.

As stated in the above-mentioned publication, the mosaic may be constructed in various ways. In a preferred construction a mica sheet 15 has a metallic coating or signal plate 17 formed on the back side and the mosaic 13 formed on the front side which consists of a very large number of minute silver globules each of which is photosensitized by means of caesium. The light-sensitive silver globules are insulated from each other and each globule has a certain amount of capacity to the metallic coating 17.

In order to scan the mosaic with the electron beam deflecting coils 19 may be provided for deflecting the electron beam vertically and deflecting plates 21 provided for deflecting the beam horizontally.

A high voltage power supply unit 23 is provided for supplying the various electrodes of the cathode-ray tube 1 with the proper voltage. The input circuit of the power supply unit 23 is connected to a suitable power source, such as a 60-cycle power line 25, while the output circuit is connected to a voltage divider 27. The cathode 5 is connected to a suitable point on the voltage divider 27 near its negative end, while the control grid 7 is connected to a point on the voltage divider 27 which is negative with respect to the cathode 5. The first and second anodes 9 and 11, respectively, are connected to points on the voltage divider which are positive with respect to the cathode 5.

A voltage impulse generator 29 is provided which may be the same as that described and claimed in my copending application Serial No. 728,147, filed May 29, 1934, and assigned to the Radio Corporation of America. In this form of impulse generator the impulses are generated by means of a rotatable disc having suitable openings therein through which light may pass to strike a photoelectric cell, the disc being driven by a synchronous motor. As indicated on the drawings, the synchronous motor (not shown) is supplied through conductors 31 with current from the 60-cycle line 25.

The generator 29 supplies vertical deflecting impulses through a conductor 33 to a vertical deflecting circuit 35 which supplies a saw-tooth current to the deflecting coils 19. Horizontal deflecting impulses are supplied through a conductor 37 to a horizontal deflecting circuit 39 which supplies saw-tooth voltage waves to the deflecting plates 21. In one particular transmitter the vertical deflecting impulses occur 60 times per second, while the horizontal deflecting impulses occur 7290 times per second to provide 121½ lines per picture, whereby the so-called interlaced scanning is produced. Assuming a picture has been projected onto the mosaic 13, as the mosaic is scanned from bottom to top (since the image is inverted), picture signals will appear across a resistor 41 which is connected between the signal plate 17 and ground.

With regard to the frequency of the vertical deflecting impulses, it is desirable that they occur at the same frequency as that of the power line 25 so that the uneven shading of the picture, due to the use of the alternating current light source 16, will remain stationary on the picture. Consequently, this type of uneven shading may be corrected for in the same manner as the type due to the cathode-ray tube characteristics.

The signals appearing across the resistor 41 are passed through an amplifier 43 and a second amplifier 45 to a radio transmitter 47. The amplifier 45 will be described in detail later in connection with Fig. 3.

The impulse generator 29 also supplies blanking impulses which are transmitted through a conductor 49 and a buffer resistor 51 to a suitable point in the amplifier 45. It also supplies synchronizing impulses 53 through a conductor and a buffer resistor 55 to the output circuit of the amplifier 45, whereby the synchronizing impulses are transmitted to the receiver together with the picture signals. The manner in which the blanking impulses and synchronizing impulses are utilized will be explained hereinafter.

The term "buffer resistor" is used in the preceding paragraph and will be used in the following paragraphs with reference to a resistor which is employed for the purpose of preventing one circuit from short-circuiting another circuit or otherwise rendering it ineffective. In the shading circuit, which is described in the following paragraphs, the buffer resistors are employed largely for the purpose of causing voltages of different wave shapes and frequencies to add to give a composite wave of the desired shape.

If only the portion of the transmitter described above were employed for transmitting a picture, the picture appearing on the fluorescent screen at the receiver would be shaded in some such manner as indicated in Figs. 6 and 7. Such uneven shading is particularly noticeable if the intensity of the electron beam is made sufficient to obtain maximum picture signal output. With the cathode-ray transmitter tube 1 illustrated in Fig. 1 it has been found that usually the appearance of the picture at the receiver is similar to the view in Fig. 6. That is, one corner of the picture will be darker than the rest of the picture.

In accordance with my invention, I provide a shading circuit by means of which the picture at the receiver may be given a substantially uniform shading. The main portion of the shading circuit is shown enclosed by the dotted rectangle. This portion of the shading circuit supplies to a shading amplifier 57 saw-tooth waves occurring at the horizontal and vertical deflecting frequencies, sine waves of the horizontal and vertical deflecting frequencies, and the second harmonics of these sine waves. The output of the shading amplifier 57 is impressed through a buffer resistor 59 upon the input circuit of the amplifier 45 where the saw-tooth waves and the sine waves are mixed with the picture signal.

Referring more specifically to the shading circuit, the saw-tooth waves of the horizontal deflecting frequency are supplied from the horizontal deflecting circuit 39 through a conductor 61 and through a coupling condenser 63 and buffer resistor 65 to a potentiometer resistor 67 which is grounded at one end. The saw-tooth voltage wave is taken off the potentiometer 67 through a slideable contact 69 and transmitted through a resistor 71 to a switch arm 73 which may be connected either to a bus bar 75 or to a bus bar 77.

The bus bars 75 and 77 are so connected through conductors 76 and 78, respectively, to different points in the shading amplifier 57 that a signal supplied to the amplifier from one bus bar will appear in the amplifier output 180° out of phase to a similar signal supplied to the amplifier from the other bus bar. The manner in which the phase of a shading or correcting signal may be reversed will be understood by referring to Fig. 2.

As shown in Fig. 2, the shading amplifier 57 comprises three vacuum tubes 79, 81 and 83 which may be of the suppressor grid type. These amplifier tubes are connected in cascade in a conventional manner by means of resistance coupling, each tube being provided with the proper bias from a self-biasing resistor. It will be seen that the conductor 76 leading from the bus bar 75 is connected to the input circuit of the first amplifier tube 79, while the conductor 78 leading from the other bus bar 77 is connected to the input circuit of the second amplifier tube 81. In order to prevent the plate circuit of the first amplifier tube from shunting out most of the signals supplied over the conductor 76, a resistor 85 of comparatively high value is provided in series with the coupling condenser 87. It will be evident that two like signals impressed upon the two conductors 76 and 78 will appear in the output circuit of the amplifier 57 in opposite phase.

In order to provide a sine wave of the horizontal deflecting frequency, the saw-tooth wave supplied over the conductor 61 is impressed through a buffer resistor 89 upon a circuit which is tuned to the horizontal deflecting frequency (7290 cycles per second in the specific circuit being described). This circuit consists of an inductance coil 91 having condensers 93 and 95 connected in parallel therewith. The condenser 93 is connected directly across the inductance coil 91, while the other condenser 95 is connected across the coil 91 through a variable resistor 97 for the purpose of shifting the phase of the sine wave voltage. In order to obtain a more perfect sine wave, the output of the first tuned circuit is impressed through a resistor 99 upon a second circuit consisting of an inductance coil 101 and a condenser 103 tuned to the horizontal deflecting frequency. The sine wave voltage may be taken from a potentiometer 105 which is connected across the tuned circuit and supplied through a movable contact 106 and a buffer resistor 107 either to the bus bar 75 or the bus bar 77, depending upon the position of a switch 109.

The action of the phase-shifting resistor 97 is to effectively connect more or less of the capacity of the condenser 95 across the inductance coil 91 whereby the circuit may be tuned either exactly to the horizontal deflecting frequency or to either side of the resonant point.

In order to obtain a second harmonic of the horizontal deflecting frequency, the saw-tooth wave from the conductor 61 is supplied through a buffer resistor 111 to a tuned circuit consisting of an inductance coil 113 and condensers 115 and 117. As in the circuit described above, a variable resistor 119 connected in series with the condenser 117 is provided for shifting the phase of the second harmonic voltage.

The voltage appearing across the tuned circuit 113, 115, 117 is impressed across a potentiometer 121 through a filter consisting of series resistors 123 and 125 and a shunt condenser 127. This filter is provided in order to remove the high frequency components of the saw-tooth wave which are not removed by the tuned circuit. The second harmonic voltage is taken from the potentiometer 121 through a movable contact 129 and a buffer resistor 131 to a switch 133 where it may be impressed upon either one of the bus bars.

A saw-tooth voltage of the vertical deflecting frequency is supplied from the vertical deflecting circuit 35 through a conductor 135, a coupling condenser 137, and a buffer resistor 139 to a potentiometer 141. The saw-tooth voltage is taken from the potentiometer 141 through a movable contact 143 and a buffer resistor 145 to a switch 147 which may be connected to either bus bar.

The sine wave voltage of the vertical deflecting frequency may be derived from the vertical saw-tooth wave, if desired, in the same manner in which the sine wave voltage of the horizontal frequency is produced. In the embodiment illustrated, however, since the vertical deflecting frequency is the same as the frequency of the power line, the lower frequency sine wave voltages are derived directly from the power line.

A 60 cycle current is supplied through a transformer 149 having a primary winding 151 and a secondary winding 153 to a potentiometer 155.

The potentiometer 155 is supplied with current from the secondary winding through a phase shifting network which includes a variable resistor 157 and a condenser 159 connected across the secondary winding. The potentiometer 155 is connected between the junction point of the condenser 159 and variable resistor 157 and the midpoint of a voltage divider 161 which is shunted across the secondary winding. The vertical frequency sine wave voltage is taken off the potentiometer 155 through a movable contact 163 and a buffer resistor 165 to a switch 167 which may be connected to the desired bus bar.

The second harmonic of the vertical deflecting frequency is also derived from the 60 cycle line current. The circuit for supplying the second harmonic voltage includes a transformer 169 having a primary winding 171 and a secondary winding 173. The mid-point of the primary winding 171 is connected to one side of the 60 cycle line through a conductor 175 while the upper and lower ends of the primary winding are connected to the other side of the power line through a condenser 177 and a variable resistor 179, respectively. By varying the value of the resistor 179 the phase of the current appearing in the output circuit of the transformer 169 may be shifted.

In order to provide a strong second harmonic, the output of the transformer 169 is passed through a double-wave rectifier. The rectifier electrodes are elements of a vacuum tube 181 which includes a cathode 183, rectifier plate electrodes 185 and 187, a control grid 189, and an anode 191; the cathode, the control grid and the anode functioning as elements of an amplifier tube. The ends of the secondary winding 173 are connected to the rectifier plates 185 and 187 while the midpoint of a voltage divider 193, which is connected across the secondary winding 173, is connected to the cathode 183 through a resistor 195. The voltage which appears across the resistor 195 is impressed upon the control grid 189 whereby it is amplified to produce a strong second harmonic voltage in the plate circuit of the amplifier section of the tube 181.

The plate circuit includes an inductance coil 197 and a condenser 199 which are tuned to the frequency of the second harmonic voltage so that a substantially pure second harmonic sine wave is supplied to a potentiometer 201 which is connected across the output circuit. As in the other shading circuits, the voltage appearing across the potentiometer 201 is supplied through a movable contact 203 and a buffer resistor 205 to a switch 207 which may be connected to either bus bar.

In order to more completely disclose my invention, I have shown in Fig. 4 one form of a vertical deflecting circuit from which the saw-tooth shading impulses may be derived. The particular circuit illustrated in Fig. 4 comprises an amplifier tube 209, which may be of the three element type having an input circuit which is supplied with the vertical deflecting impulses from the conductor 33. The plate circuit of the amplifier tube 209 includes a plate resistor 211 through which voltage is supplied to the plate of the amplifier tube.

The plate circuit of the tube 209 also includes a peaking resistor 213 and a condenser 215 which are connected in series across the plate voltage supply (not shown) and the plate resistor 211 whereby the condenser 215 is charged through the two resistors 211 and 213 by the plate supply. Since the condenser 215 is being charged through a circuit including a large amount of resistance it is charged in a substantially linear manner until a vertical deflecting impulse is impressed upon the input circuit of the amplifier tube 209. This impulse causes the control grid of the tube 209 to become more positive whereby the condenser 215 discharges through the said tube. At the end of this impulse the condenser again receives a substantially linear charge until the next vertical deflecting impulse occurs. During the time of charge, the plate current of the tube 209 is substantially zero because of the negative charge retained on its grid due to electrons collected by said grid during the discharge period. In this manner a saw-tooth wave voltage wave is produced across the condenser 215. This saw-tooth voltage is impressed through a coupling condenser 217 upon the input circuit of an amplifier tube 219. The amplified saw-tooth wave is then supplied through the conductor 135 to the shading circuit as previously described.

The voltage appearing across the condenser 215 and the peaking resistor 213 is a sum of the saw-tooth voltage appearing across the condenser 215 and a square top voltage appearing across the peaking resistor 213. This voltage is impressed through a coupling condenser 221 and a resistor 223 upon the input circuit of an amplifier tube 225 where it is amplified sufficiently to be impressed across the deflecting coils 119.

The peaking resistor 213 is provided because an impulse component must be added to the saw-tooth wave to produce a flow of saw-tooth current in the deflecting coils, this being necessary because of the inductive reactance of the deflecting coils. Since it is generally desirable to round off the top of the saw-tooth wave for varying the velocity of the vertical deflection, the input circuit of the amplifier tube 225 includes a resistor 227 and a condenser 229 connected in series whereby the impedance of the input circuit is greater for low frequencies than for high frequencies. The condenser 229 is shunted by a variable resistor 231 in order to control the effectiveness of the condenser 229 in increasing the low frequency response of the amplifier 225. The feature of controlling the velocity of the vertical deflection of the cathode ray is described and claimed in my copending application Serial No. 755,304, filed November 30, 1934, assigned to the RCA Victor Company, Inc.

In Fig. 5 there is illustrated a television receiver for receiving pictures sent out from the transmitter illustrated in Fig. 1. The television receiver comprises a radio receiver 233 and a separating circuit 235 which separates the picture signals (including the shading signals) from the vertical and horizontal synchronizing impulses and which also separates the vertical synchronizing impulses from the horizontal synchronizing impulses. The picture and shading signals are passed through a picture amplifier 237 and impressed upon the control grid 239 of a cathode-ray receiver tube 241.

The cathode-ray tube 241 which is illustrated is of a well known type comprising an evacuated envelope 243 having an electron gun therein consisting of an indirectly heated cathode 245, the control grid 239, and a first anode 247. A second anode 249 consisting of a metallic coating on the inner surface of the envelope 243 is provided for accelerating the electrons in the electron beam and for aiding in the focusing of the beam. A fluorescent screen 251 is provided at the end of the tube where it may be scanned by the electron beam for producing a picture. In order to deflect the electron beam both horizontally and vertically for scanning purposes, deflecting coils 253 and 255, respectively, may be provided.

The horizontal synchronizing impulses are impressed upon a horizontal deflecting circuit 257 which supplies to the horizontal deflecting coils 253 a saw-tooth current under the control of the synchronizing impulses. The vertical synchronizing impulses are supplied to a vertical deflecting circuit 259 which supplies saw-tooth current to the vertical deflecting coils 255, this current being under the control of the vertical synchronizing impulses whereby the electron beam in the cathode-ray tube is caused to scan the fluorescent screen 251 in synchronism with the scanning of the mosaic 13 at the transmitter.

It will be understood that Figs. 6 and 7 are views of the end of the tube 241 when it is being scanned with the transmitter mosaic uniformly illuminated and with no shading or correcting signals being transmitted. It will be noted that the views shown in Figs. 6 and 7 are drawn to a different scale than the cathode-ray tube shown in Fig. 5.

At the transmitter, a monitor receiver is provided as indicated at 258 in Fig. 1. The end of the receiver tube is indicated at 260, the shading on the fluorescent screen being the same as shown in Fig. 6. Except that the radio receiver is omitted, the monitor receiver is the same as the receiver illustrated in Fig. 5.

The operation of my improved television system will now be described particularly with reference to Fig. 3 showing the circuit of the amplifier 45 and with reference to Figs. 8 to 17 showing various voltage curves. In this description of the operation of the shading circuit it will be assumed that, without any correction, a picture appearing on the fluorescent screen 251 is shaded as shown in Fig. 6. This assumption will be made for the sake of simplifying the explanation, although, as a matter of fact, it has been found that the shading usually is a combination of the type of shading shown in Fig. 6 and of that shown in Fig. 7.

Referring to Fig. 3, the amplifier 45 comprises four amplifier tubes 261, 263, 265 and 267 which are coupled in cascade by means of resistance coupling. All of the tubes are properly biased to function as amplifier tubes either by means of biasing batteries, as illustrated, or in any other suitable manner. It may be desirable to bias the last amplifier tube 267 somewhat more negatively than the preceding tubes in order that it will function more effectively as a "clipping" tube as will be understood from the following description.

The signal output of a cathode-ray transmitter tube, which produces the shading represented in Fig. 6, has the characteristic illustrated by the curve 269 in Fig. 8. In order to simplify the curve, only a few lines per picture have been indicated. In this curve the picture signals for each horizontal scanning line are represented by the portions x, while the portions y of the curve, located between successive horizontal line signals, are undesired transient signals which are produced during the horizontal return line period. At the point z on the curve, one picture frame has been completed and the cathode-ray is being returned to begin the next scanning of the picture.

It will be apparent that the zero axis for each horizontal line picture signal represented at x slopes downwardly while the zero axis for the entire group of picture signals of one frame slopes upwardly. It will be apparent that, with the black signal in the direction indicated on the drawings, the signal will result in a shading at the receiver such as shown in Fig. 6, it being understood that the fluorescent screen 251 is scanned from top to bottom and (when looking at the picture) from left to right.

In order to shade the picture evenly, the saw-tooth voltage waves shown in Figs. 9 and 11 are mixed with the picture signal, the saw-tooth waves shown in Fig. 9 occurring at the horizontal scanning frequency and the saw-tooth waves shown in Fig. 11 occurring at the frame frequency. The first saw-tooth voltage corrects the picture signal to produce a signal such as shown in Fig. 10, while the other saw-tooth voltage further corrects the picture signal to produce the signal shown in Fig. 12, this curve having a zero axis which is horizontal.

It will be understood that where shading of the character shown in Fig. 7 is present, as is usually the case, sine waves also will be added to the picture signal to shade the picture evenly. However, it is not thought desirable to complicate the explanation of the invention by drawing curves to illustrate shading by the use of sine waves. Therefore, the type of shading which may be compensated by only two saw-tooth waves has been assumed.

Referring to Fig. 3, it will be seen that the two shading voltages and the picture signal, indicated at 269, are introduced into the input circuit of the first amplifier tube 261 where they add to give the curve shown in Fig. 12. The polarity of the signals is reversed by the first amplifier tube as indicated by the curve 271 (Fig. 3).

The polarity of the signal is again reversed by the second amplifier tube 263 to produce an amplified signal similar to the one shown in Fig. 12. This signal, and blanking impulses of the character shown in Fig. 13, are impressed upon the input circuit of the third amplifier tube 265 where they add to give a signal represented by the curve shown in Fig. 14. It will be noted that the undesired transients now appear on the top of the blanking impulses where they are removed from the region of the picture signals.

The signal appears in reversed phase in the output circuit of the amplifier 265 as indicated by the curve 273 (Fig. 3) and is then impressed upon the last amplifier 267. Since the blanking impulses and superimposed transients are of considerable magnitude and are in a negative direction, they drive the tube 267 beyond the cut-off point, indicated by the dotted line 274, and the transients are "clipped off" to produce a signal in the output of the amplifier which is represented by the curve 275 shown in Fig. 3 and in Fig. 15.

Synchronizing signals of the character indicated in Fig. 16 are impressed upon the output circuit of the amplifier 267 where they add to the amplifier output to give the signal represented by the curve in Fig. 17. It will be apparent that the undesired transient signals have been entirely eliminated. It will also be apparent that unless the zero axis of the picture signals were corrected before the signals were impressed upon the clipping tube 267 either some of the transient voltages would not be eliminated or it would be necessary to so limit the output of the cathode-ray transmitter tube that the zero axes of its signal output would have less than a predetermined slope.

In transmitting a picture, the procedure is as follows: An operator at the transmitting station so adjusts the monitor that the picture appearing on the tube 260 is rather dim whereby any irregularities in shading will be readily apparent. He then closes such bus bar switches, 73, 109, etc., as he thinks necessary for correcting any uneven shading that is apparent. The potentiometer contacts 69, 106, etc., and the phase shifting devices are then adjusted. An experienced operator can shade a picture properly without much difficulty. Usually the shading changes with the character of the picture being transmitted so that the operator must watch the monitor tube and change certain shading adjustments from time to time.

It will be understood, of course, that in shading a picture other harmonics of the vertical and horizontal deflecting frequencies than those produced by the circuit shown in Fig. 1 may be utilized, if desired.

By employing my invention a cathode-ray transmitter tube may be operated at its maximum sensitivity or efficiency and, at the same time, a properly shaded picture obtained at the receiver. Also, the signals impressed upon the receiver will be free from transient signals and the like which would impair the quality of the picture.

It will be understood from the foregoing description that various modifications may be made in my invention without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. In combination, a cathode-ray picture transmitter tube of the type comprising a mosaic of electron emissive capacity elements which are to be scanned by an electron beam to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing shading signals of a predetermined wave shape, and means for mixing said shading signals with said picture signals for balancing out said spurious signals, said shading signals having the characteristic that they affect the relative illumination in different parts of the picture.

2. In combination, a cathode-ray picture transmitter tube of the type comprising a mosaic of electron emissive capacity elements which are to be scanned by an electron beam to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing signals of saw-tooth wave shape and signals of sine wave shape with said picture signals, and means for mixing all of said signals for balancing out said spurious signals to produce a correctly shaded picture.

3. In a picture transmission system, means for generating picture signals and undesired spurious signals which unevenly shade a picture reproduced by said picture signals, means for generating saw-tooth wave signals and sine wave signals which occur simultaneously with said picture signals, means for so adding all of said signals as to balance out said spurious signals, and

means for transmitting the resulting composite signal.

4. In a picture transmission system, the combination of a cathode-ray transmitter tube which generates picture signals of a character which produce a picture of uneven shading at the receiver due to spurious signals which unevenly shade the picture, and means located at the transmitter for balancing out at least part of said spurious signals to correct said uneven shading, said means comprising means for generating saw-tooth and sine wave voltages which occur simultaneously with said picture signals and for adding them to said picture signals.

5. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron-emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing a correcting signal which occurs simultaneously with said picture signals, said correcting signal having a fundamental frequency equal to one of said deflecting frequencies, and means for so adding said correcting signal to said picture signals as to balance out said spurious signals.

6. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing a correcting signal which occurs simultaneously with said picture signals, said correcting signal having a fundamental frequency which is equal to a whole number multiple of one of said deflecting frequencies, and means for so adding said correcting signal to said picture signals as to balance out said spurious signals.

7. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode ray to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing at least two correcting signals which occur simultaneously with said picture signals, and means for adding said correcting signals to said picture signals for balancing out said spurious signals, one of said correcting signals having a fundamental frequency equal to said horizontal deflecting frequency, and the other of said correcting signals having a fundamental frequency equal to said vertical deflecting frequency.

8. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, and means for adding a correcting signal to said picture signals for balancing out said spurious signals, said correcting signal having a saw-tooth wave form and having a fundamental frequency equal to one of said deflecting frequencies.

9. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, and means for adding at least two correcting signals to said picture signals for balancing out said spurious signals, one of said correcting signals having a fundamental frequency equal to said horizontal deflecting frequency, and the other of said correcting signals having a fundamental frequency equal to said vertical deflecting frequency, said two correcting signals having substantially a saw-tooth wave form.

10. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, and means for adding at least two correcting signals to said picture signals for balancing out said spurious signals, one of said correcting signals having a fundamental frequency equal to said horizontal deflecting frequency, and the other of said correcting signals having a fundamental frequency equal to said vertical deflecting frequency, said two correcting signals having substantially a sine wave form.

11. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, and means for adding a plurality of correcting signals to said picture signals for balancing out said spurious signals, two of said correcting signals having a saw-tooth wave form and two of them having a sine wave form, one saw-tooth signal and one sine wave signal having a fundamental frequency equal to said vertical deflecting frequency, and another saw-tooth signal and a sine wave signal having a fundamental frequency equal to said horizontal deflecting frequency.

12. Apparatus according to claim 5 characterized in that means is provided for shifting the phase of said correcting signal.

13. In a picture transmitter, a cathode-ray

transmitter tube having an output circuit and including means for producing an electrical image of the picture to be transmitted, said tube having a vertical deflecting device and a horizontal deflecting device whereby the cathode-ray may be deflected vertically and horizontally simultaneously to produce picture signals and undesired spurious signals which unevenly shade the picture, said spurious signals having one saw-tooth component occurring at the vertical deflecting frequency and having another saw-tooth component occurring at the horizontal deflecting frequency, means for supplying a saw-tooth electrical wave occurring at the vertical deflecting frequency to said vertical deflecting device, means for supplying a saw-tooth electrical wave occurring at the horizontal deflecting frequency to said horizontal deflecting device, and means for adding signals derived from said last two means to the signals appearing in said output circuit for balancing out said spurious signals.

14. In a picture transmitter, a cathode-ray transmitter tube having an output circuit and including means for producing an electrical image of the picture to be transmitted, said tube having a vertical deflecting device and a horizontal deflecting device whereby the cathode-ray may be deflected vertically and horizontally simultaneously to produce picture signals and undesired spurious signals which unevenly shade the picture, said spurious signals having a saw-tooth component occurring at the vertical deflecting frequency and having another saw-tooth component occurring at the horizontal deflecting frequency and also having sine wave components, means for supplying a saw-tooth electrical wave occurring at the vertical deflecting frequency to said vertical deflecting device, means for supplying a saw-tooth electrical wave occurring at the horizontal deflecting frequency to said horizontal deflecting device, and means for adding saw-tooth and sine wave signals derived from said last two means to the signals appearing in said output circuit for balancing out said spurious signals.

15. In a picture transmitting system of the type in which a cathode-ray tube generates an output signal which includes picture signals and transients and in which the zero axis of said signals varies as the signals are generated due to undesired spurious signals which unevenly shade the picture, the method of eliminating said transients which consists in mixing correcting signals with said output signal, said correcting signals having a wave shape such as to balance out said spurious signals and correct for the said variation in the zero axis, mixing electrical impulses with said output signal, said impulses occurring at the same time as said transients and being of sufficient magnitude to remove the transients from the region of said picture signals, and clipping said transients from the resulting signal.

16. In a picture transmitter, a cathode-ray transmitter tube of the type including a mosaic of electron emissive capacity elements, means for sweeping the cathode-ray horizontally across said mosaic at a horizontal deflecting frequency, means for deflecting said cathode-ray simultaneously in a vertical direction at a vertical deflecting frequency whereby said mosaic is scanned periodically by said cathode-ray to produce picture signals and undesired spurious signals which unevenly shade the picture, means for producing simultaneously with said picture signals a sine wave signal which has a frequency equal to the second harmonic of one of said deflecting frequencies, and means for adding said sine wave signal to said picture signal for balancing out said spurious signals.

17. Apparatus according to claim 16, characterized in that means is provided for shifting the phase of said sine wave.

18. Apparatus according to claim 5, characterized in that means is provided for reversing the polarity of said correcting signal.

ALDA V. BEDFORD.