Aug. 11, 1942. A. V. BEDFORD 2,292,817

TELEVISION SYSTEM

Filed July 31, 1940 2 Sheets-Sheet 1

FIG. 1.

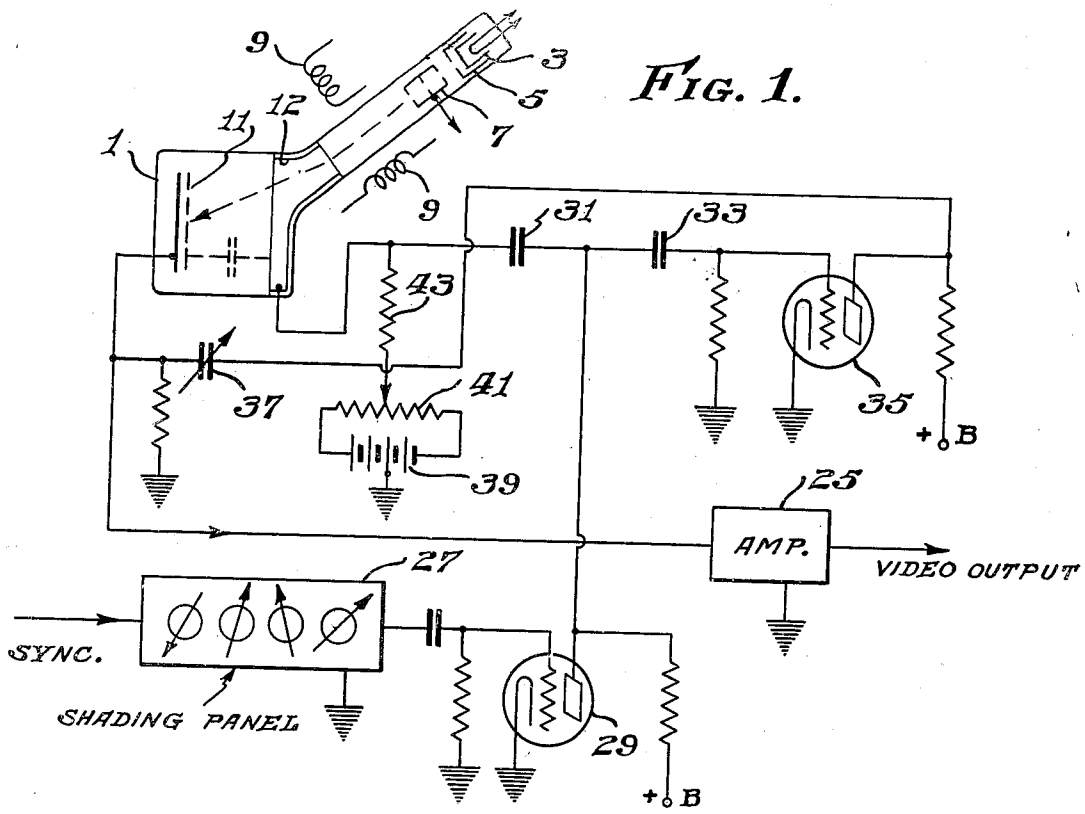
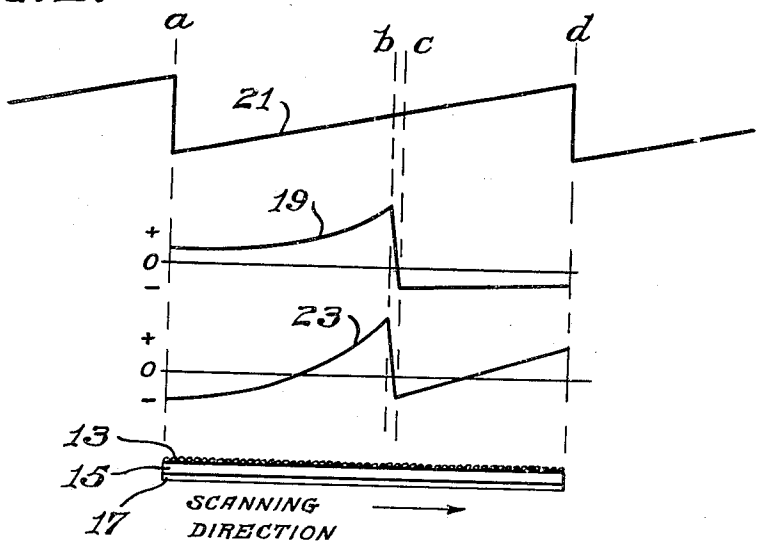


FIG. 2.



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By

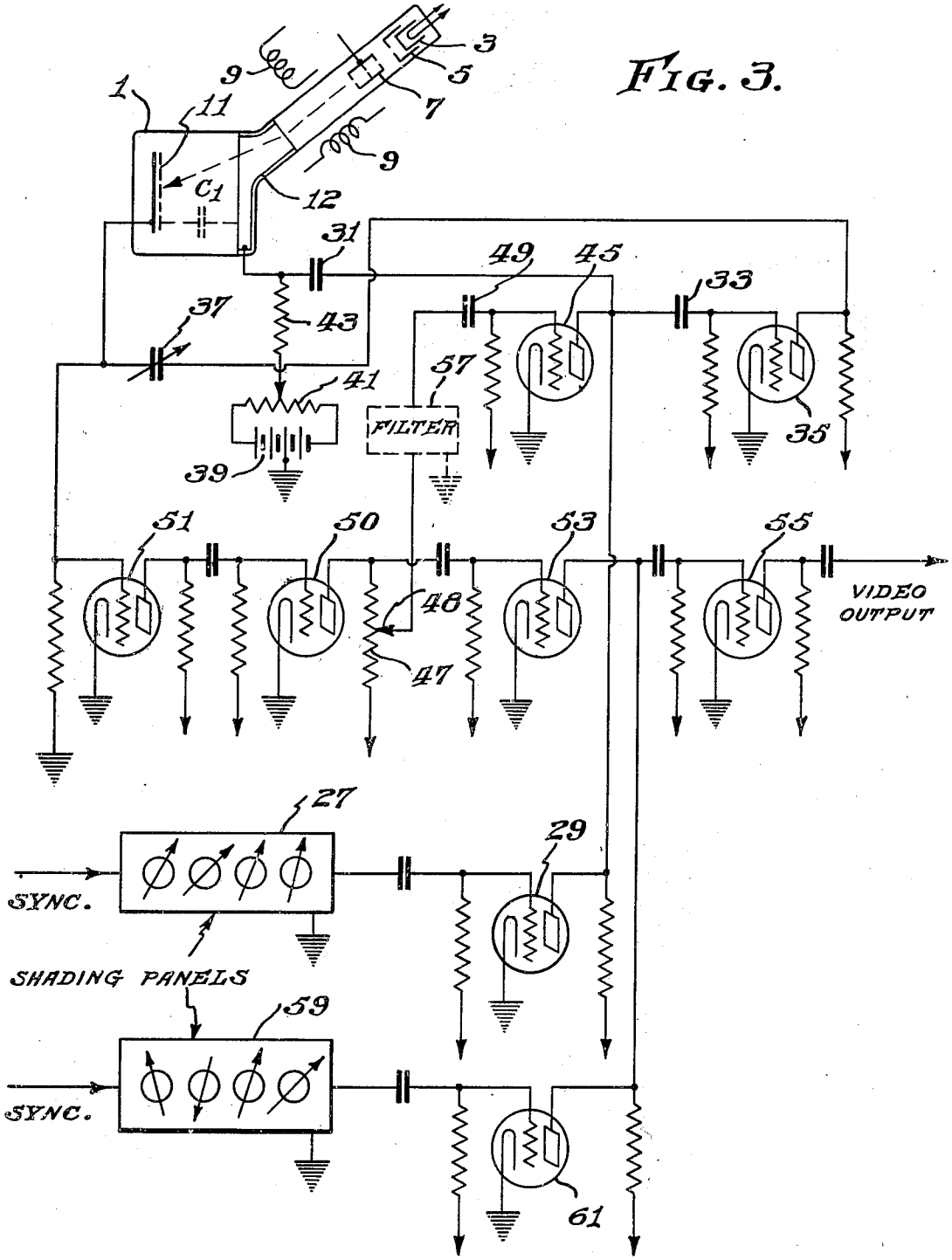
Attorney

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FIG. 3.



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UNITED STATES PATENT OFFICE

2,292,817

TELEVISION SYSTEM

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Application July 31, 1940, Serial No. 348,876

7 Claims. (Cl. 178—7.2)

This invention relates to television systems and more particularly to improvements in cathode ray transmitter tube circuits.

In television systems employing a cathode ray transmitter tube for converting an optical image into a train of electrical pulses, 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 side or corner of the picture may be very dark, while a side or corner diagonally opposite the dark corner may be very light. This is commonly referred to as "shading." It has been found that this undesired shading is caused by the nonuniform resettling of secondary electrons which have been driven from the mosaic during the bombardment of the mosaic by the cathode ray electron beam. A collector element is usually employed to remove these secondary electrons but it has been found that the collector does not attract all of the secondary electrons but many of them return to the mosaic surface and cause a spurious charge from which is derived an undesired shading signal which ultimately results in a nonuniformly shaded image.

In Patent No. 2,166,712, issued July 18, 1939, I have described and claimed a system for balancing out the shading signal by introducing into the video signal amplifier a wave shape whose polarity and amplitude is such that it will balance out the undesired shading signal component present in the video signal amplifier.

According to the present invention, I propose to prevent the generation of the shading signal rather than the balancing out of the shading signal so that there will be no possibility of overloading the video signal amplifier, and furthermore that any distortion, which is caused by the nonlinearity of the cathode ray transmitter tube and amplifier over the comparatively large light range necessitated because of the introduction of the shading signal, will be illuminated. A signal having a wave shape including a saw-tooth wave component is impressed upon the collector in synchronism with the frequency of scanning of the mosaic by the electron beam to alter the charge remaining on various areas of the mosaic and therefore effecting the redistribution of the secondary electrons over the whole of the mosaic surface.

The primary object of this invention is to provide a method and means for the prevention of shading in television images.

Another object of this invention is to provide an improved method and means for preventing the transmission of undesired shading signals.

Other and incidental objects of the invention will be apparent to those skilled in the art from consideration of the following specification in connection with the accompanying drawings, in which

Figure 1 is a circuit diagram showing one embodiment of this invention,

Figure 2 is a graphical illustration of the operation of one form of this invention, and

Figure 3 is a circuit diagram showing a modification of this invention.

Referring to Fig. 1, the transmitter includes a cathode ray transmitter tube 1 which may be of the type described in an article of V. K. Zworykin, published in the January 1934 issue of the Proceedings of the Institute of Radio Engineers. The cathode ray transmitter tube 1 comprises an evacuated envelope having located therein an electron gun comprising a cathode 3, a control electrode 5, and a first anode 7. Deflecting coils 9 are provided for deflecting the electron beam over a mosaic 11 of electron-emissive capacity elements. The mosaic 11 is so positioned inside the envelope that an optical image may be projected thereon whereby its capacity elements are charged in accordance with the intensity of the light striking the mosaic surface. A collector 12 or control electrode is provided to attract secondary electrons driven from the mosaic during electronic bombardment by the electron beam.

Referring now to Fig. 2, an edge view of the mosaic is represented by 13. The mosaic insulating element 15 separates the mosaic or photosensitive elements 13 from the supporting and conducting element 17. The curve 19 represents graphically the potential along a scanning line on the mosaic surface resulting from secondary emission caused by the impact of the electron beam on the electron-emissive elements of the mosaic.

If we assume that the electron beam is traveling in the direction *a* to *d* and, for the purpose of illustration, striking the mosaic in the area *b*—*c*, the secondary electrons which are driven off the surface of the mosaic because of the impact of the electron beam are attracted to the collector or electrode element 12 in the tube and also to any surrounding area having a positive charge. The loss of electrons from any area in the mosaic surface results in that point having a positive charge with respect to the surrounding area. It, therefore, follows that the

areas over which the electron beam has just previously scanned are at a somewhat positive potential with respect to their surrounding areas. This area of a positive charge may be represented on curve 19 by *a*—*b*. It follows that any electrons driven from the mosaic surface area *a*—*b* will be attracted to point *b* and that portion of the curve 19 between *a* and *b* which is at a relatively positive potential with respect to its adjacent area of the mosaic. It will be noticed that the flow of secondary electrons will necessarily be in the direction opposite to that direction of movement of the scanning beam. Therefore, this migration of secondary electrons is generally in one direction causing one edge or corner of the mosaic to become more negatively charged than the opposite edge or corner, thus resulting in the effect usually referred to as shading.

The charge remaining on each element of the surface being scanned is a function of the collector voltage which is usually maintained at a fixed potential relative to the mosaic surface. According to this invention, however, a voltage of a certain wave shape, for example, that represented by curve 21 in Fig. 2, is impressed upon the collector in synchronism with the scanning, thus altering the charge remaining on the various areas of the mosaic and resulting in a redistribution of electrons. As the potential on the collector element is increased in the positive direction, as shown in the curve in the direction *a*—*d*, more secondary electrons are attracted to the collector element and, therefore, less electrons return to the mosaic causing that portion of the mosaic to have a positive charge. This results in an alteration of curve 19 to a form shown by curve 23. It will be noted that curve 23 is very similar to curve 19 with the exception that the axis of the curve is tilted so that a portion of curve 19 between *c* and *d* which heretofore remained at a negative potential is caused to increase in a positive direction because of the more positive collector, so that a portion of the area *c*—*d* preceding the scanning beam is maintained at a positive potential. Therefore, the secondary electrons emitted from area *b*—*c* on curve 23 are attracted not only in the backward direction represented by *a*—*b* but they are also attracted in the forward direction *c*—*d* because of the positive charge on the mosaic elements which are ahead in direction of movement of the electron beam.

Returning now to Fig. 1, the useful signal pulses resulting from the scanning of the mosaic element 11 are fed through the amplifier 25 to the video output channel.

A shading panel 27 or other suitable means is provided to supply an auxiliary signal having a saw-tooth wave component to the amplifier tube 29 which in turn applies this auxiliary signal voltage to the collector 12 through coupling condenser 31. The shading panel and circuits may be of the type described in my United States Patent No. 2,166,712, issued July 18, 1939. Their function is to adjust the amplitude and wave shape of the auxiliary signal. The potential source supplying the auxiliary signal voltage to the shading panel and amplifier may be the same source which supplies the deflecting circuits of the cathode ray transmitter or it may be any other form of saw-tooth wave voltage source synchronized with the associated deflection circuits.

The output of the amplifier tube 29 is also fed to a neutralizing circuit comprising a coupling condenser 33, an amplifier tube 35, and a neutralizing condenser 37. This circuit is provided to neutralize the effect of the auxiliary voltage of the collector element on the mosaic element because of cathode ray tube interelectrode capacity. Bias voltage on the collector element is provided from a circuit comprising a battery or other D. C. potential source 39 across which is connected a potentiometer 41 whose variable tap is in series with a resistance 43 connected to the collector element 12.

Referring now to Fig. 3, wherein like reference numerals refer to similar parts, a portion of the signal from the mosaic element is applied to the collector of the transmitter tube 1. The discharge device 45 which supplies the collector through coupling condenser 31 is supplied by a voltage taken from the potentiometer 47 through its variable tap 48 and coupling condenser 49. The potentiometer 47 is connected in the anode circuit of tube 50 in the video signal amplifier which comprises tubes 50, 51, 53 and 55. This amplifier may be of any of the well-known types used for the amplification of video signals.

As has been previously described when no auxiliary signal is impressed on the collector, a shading signal is present in the useful picture signal. This shading signal takes the approximate form of a saw-tooth wave whose frequency is equal to the scanning frequency. Therefore, if a portion of signal of the proper polarity from the mosaic element is amplified and returned to the collector, the saw-tooth wave component of the signal taken from the mosaic will cause a reduction in the generation of the shading signal in the manner previously described in which an auxiliary signal having a saw-tooth wave component was applied to the collector. It is true that, with this method, the shading signal will not be completely eliminated because it necessarily requires a small amount of shading signal in the video frequency amplifier to maintain a signal having a saw-tooth wave shape on the collector. However, this very small amount of spurious signal will shade the optical image only a very small amount.

Furthermore, the polarity and amplitude of the potential impressed upon the collector through tube 45 is such that, as a greater amount of secondary electrons are emitted from the mosaic, a positive signal is impressed upon the collector tending to draw more electrons to the collector. It will be understood that this change in potential of the collector has no direct effect upon the useful signal taken from the mosaic 11 because, as previously explained in connection with Fig. 1, a neutralizing circuit is adjusted to balance out any effect between the collector 12 and the mosaic 11 resulting from interelectrode capacity. The only effect that the change in potential of the collector 12 will have is to effect the desired distribution of the free secondary electrons. The area scanned while the collector is swung, for example, in the positive direction, will reach equilibrium under the beam influence at a higher positive potential. It follows then that, when other areas are scanned and the collector is swung to a negative potential or a potential less positive, the first area scanned will attract resettling secondary electrons. The net effect will be to provide a more uniform resettling of the secondary electrons and consequently a reduction in the spurious signals causing undesired shading.

It can be shown that this function will also tend to reduce changes in the flow of electrons to the collector which process produces the useful signal. This indirect result is, of course, undesirable, but the signal will be reduced very much less in proportion to the reduction of the extraneous signal. The reason for this will be readily understood because of the nonlinearity of the transmitter tube wherein, as previously described, the change in potential of the collector affects directly only the secondary electrons and not the useful signal resulting from the photoelectric emission qualities of the mosaic elements. By inserting a low-pass filter 57 in the circuit supplying auxiliary voltages to the collector, the high frequency component of the video signal may be prevented from reaching the collector, thus reducing any effect the change in potential of the collector might have on the useful signal. It is generally understood that the extraneous shading signal consists principally of a relatively low frequency component.

Still another form of this invention is also embodied in the circuit diagram shown in Fig. 3, wherein an auxiliary signal is mixed with a portion of the signal taken from the mosaic and applied to the collector. The combination of potentials derived from the synchronizing voltage source and the video amplifier result in a more complete reduction of shading. This is readily understood if one considers the effect of the edge of the mosaic plate on the free secondary electrons and various other factors which enter into a complex system so that the use of a saw-tooth wave voltage or a combination of a saw-tooth wave and a wave having a parabolic shape is not sufficient to completely eliminate shading.

Furthermore, a third source of signal may be introduced into the video signal amplifier through shading panel 59 and amplifier tube 61. The method and means of introducing a voltage having a predetermined wave shape into the amplifier for balancing out the spurious signals is disclosed in my Patent No. 2,166,712, issued July 18, 1939.

It has been found that, by combining all three methods of eliminating and balancing out the shading signals, an improved optical image may be reproduced.

By applying both an auxiliary saw-tooth wave from the shading panel 27 and a signal through the amplifier tube 45 to the collector, the cause of the extraneous signal is removed by the simple saw-tooth wave from shading panel 27 and more complex components of extraneous signals, which are of less amplitude, are reduced by the effect of the signal being impressed upon the collector through the tube 45. For this condition of operation, there can be a filter 57 inserted in the circuit between potentiometer 47 and tube 45 to selectively transmit one or more intermediate frequency bands, one band including the second to fifth harmonics of the vertical scanning frequency and another band including the region of the second to fifth harmonics of the horizontal scanning frequency, in which regions it has been found that there are spurious signals of high amplitudes.

A certain amount of distributed capacity C_1 will exist between the signal plate and the collector. Then, since AC signal is impressed upon the collector, the signal plate 11 will obtain signals from the collector 12 through C_1. According to this invention, this effect is neutralized by the action of condenser 37 which is driven by tube 35 in inverse polarity from the collector.

While several systems for carrying this invention into effect have been indicated and described, it will be apparent to one skilled in the art that this invention is by no means limited to the particular organization shown and described but that many modifications may be made without departing from the scope of this invention as set forth in the appended claims.

I claim as my invention:

1. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam adapted to scan said mosaic at a predetermined frequency for producing picture signals and an undesired spurious signal caused by nonuniform resettling of secondary electrons, the combination of an electrode so positioned that its potential controls the resettling of secondary electrons on said mosaic and so positioned that it collects secondary electrons from said mosaic, and means for applying to said electrode a saw-tooth wave signal derived from said picture signal and whose frequency is equal to said scanning frequency whereby said spurious signal is reduced.

2. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam adapted to scan said mosaic at a predetermined frequency for producing picture signals and undesired spurious signals, the combination of an electrode so positioned that its potential controls the resettling of secondary electrons on said mosaic and so positioned that it collects secondary electrons from said mosaic, and means for applying to said electrode a signal whose wave form is complementary to said picture signals and spurious signals to reduce said spurious signals.

3. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam adapted to scan said mosaic at a predetermined frequency, the combination of an electrode so positioned that its potential controls the resettling of secondary electrons on said mosaic and so positioned that it collects secondary electrons from said mosaic, and means connected between said mosaic and collector comprising a capacitive element and a discharge device for neutralizing the effect of said collector on said mosaic caused by interelectrode capacity.

4. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam adapted to scan said mosaic at a predetermined frequency for producing picture signals and undesired spurious signals, the combination of an electrode so positioned that its potential controls the resettling of secondary electrons on said mosaic and so positioned that it collects secondary electrons from said mosaic, and means for applying to said electrode a portion of said spurious signals complementary to spurious signals on said mosaic to reduce said spurious signals.

5. In a television system, a cathode ray picture transmitter tube comprising a collector of secondary electrons and a mosaic of electron-emissive capacity elements to be scanned by an electron beam to produce picture signals and undesired spurious signals, a source of electric pulses for deflecting said electron beam at a predetermined scanning frequency, means for supplying said collector with a signal derived from said source of electric pulses, means for impressing a portion of said picture signals on said collector to reduce said spurious signals, and means for com-

bining with said picture signals a potential having a saw-tooth wave component.

6. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam for scanning said mosaic at a predetermined frequency for producing picture signals and undesired spurious signals, a collector electrode positioned to collect secondary electrons released from said mosaic, and means for applying to said electrode, a shading signal of the proper wave form, amplitude and polarity to reduce said spurious signals, said shading signal occuring in a fixed time relation to said scanning.

7. In a picture-transmitting system including a mosaic of electron-emissive elements and means for producing an electron beam for scanning said mosaic at a predetermined frequency for producing picture signals and undesired spurious signals, a collector electrode positioned to collect secondary electrons released from said mosaic, and means for applying a shading signal substantially complementary to said spurious signal for reducing the amount of spurious signal in the transmitted picture.

ALDA V. BEDFORD.