

Feb. 17, 1942.

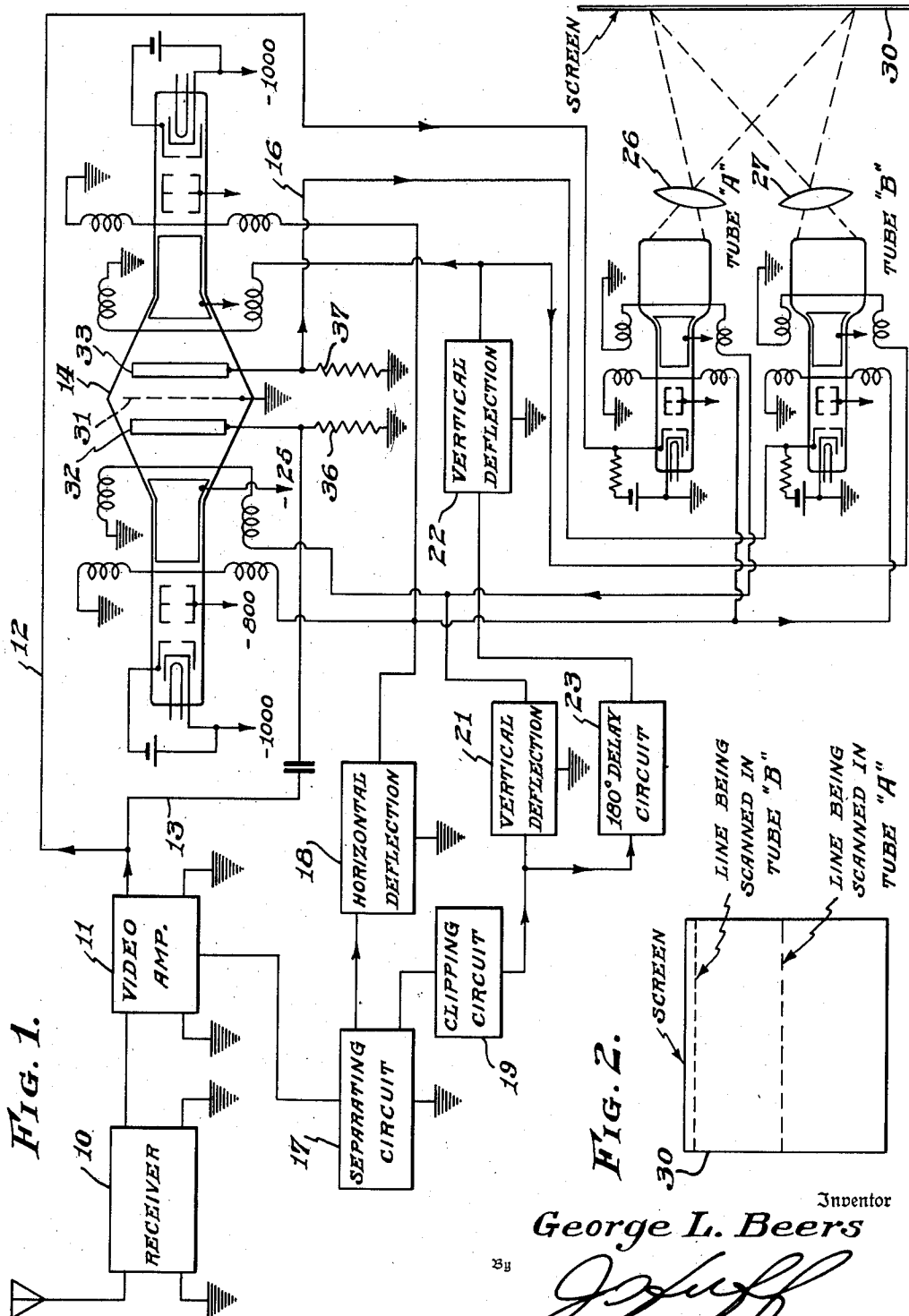
G. L. BEERS

2,273,172

TELEVISION SYSTEM

Filed Feb. 23, 1940

3 Sheets-Sheet 1



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[Signature]

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Feb. 17, 1942.

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TELEVISION SYSTEM

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3 Sheets-Sheet 2

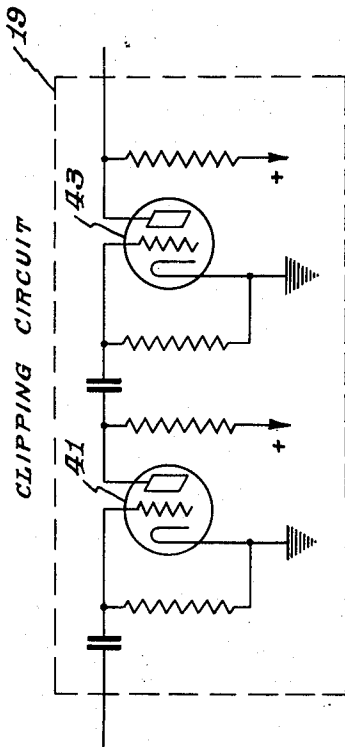
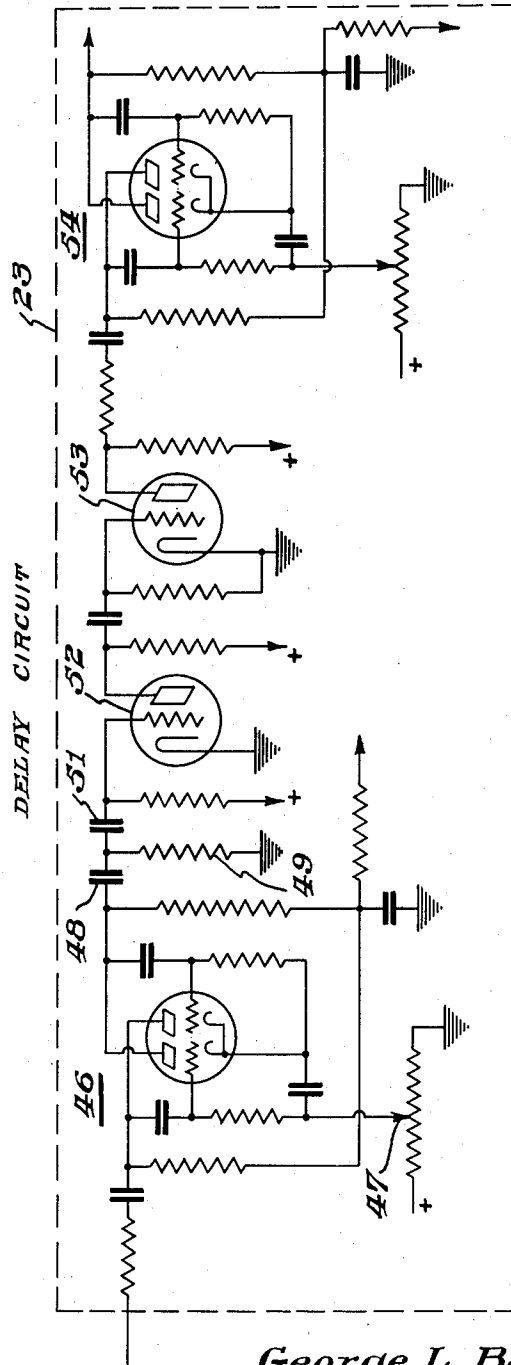


FIG. 3.

FIG. 4.



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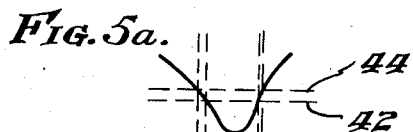


FIG. 5b.

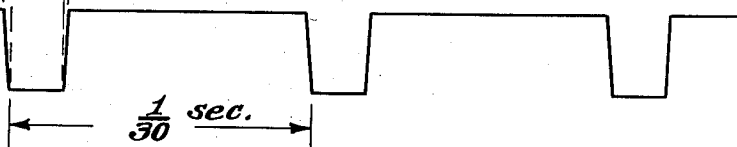


FIG. 5c.



FIG. 5d.

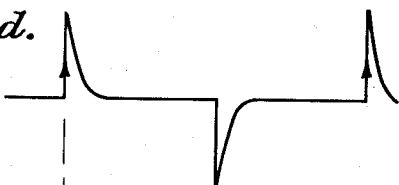


FIG. 5e.

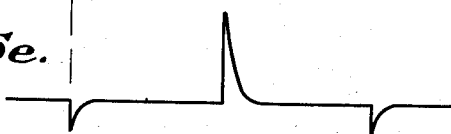


FIG. 5f.

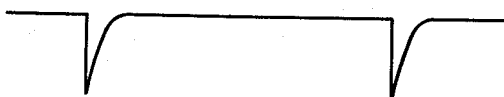
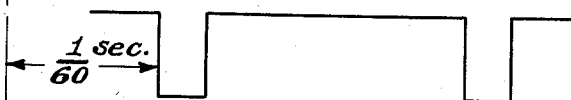


FIG. 5g.



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2,273,172

TELEVISION SYSTEM

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Application February 23, 1940, Serial No. 320,233

2 Claims. (Cl. 178—7.5)

My invention relates to television systems and has for its object to provide an improved system for and method of transmitting pictures of maximum detail over a transmission channel of a given width without flicker in the reproduced picture.

In television systems in use at the present time, it is the usual practice to employ interlaced scanning for the purpose of obtaining the maximum picture detail without flicker. If the so-called double interlaced scanning is employed, the picture frame frequency in the preferred systems in the United States is 30 per second, while the flicker frequency (in this case, the vertical deflection frequency) is 60 per second.

By means of my invention, I obtain the principal advantage of interlaced scanning, that is, maximum detail and minimum flicker, while avoiding certain disadvantages of it such as interline flicker. In a preferred embodiment of the invention, the picture is transmitted at a frame frequency of 30 per second with conventional or sequential scanning. While this frequency is so low as to cause too much flicker in a reproduced picture, it confines the picture signal to a frequency band width which is one-half of that required to transmit the same picture detail at 60 frames per second, sequential scanning. In order to avoid flicker, the received picture is supplied to two picture reproducing devices which produce two images of the picture in superimposed relation. These reproducing devices are preferably cathode ray tubes of the projector type arranged to project superimposed pictures. One of said cathode ray tubes has the received picture signal applied directly to it while the second cathode ray tube has the received picture signal applied to it through a cathode ray storage tube or the like by means of which the picture signal is delayed for substantially one-half of a picture frame period. The vertical deflection for the second cathode ray tube is likewise delayed one-half of a picture frame period. Thus, at the instant the middle scanning line is being traced by the cathode ray in one cathode ray tube, the top scanning line is being traced by the cathode ray in the second tube (assuming the scanning is top to bottom). Also, by virtue of the storage tube action, the application of the picture signal corresponding to the top scanning line to the second tube has been delayed the necessary time interval. Thus, at any point in the complete picture as it appears on the screen (at the top, for example) the picture repeats at double the frame frequency, that is, at

60 times per second in the example assumed, and flicker is substantially eliminated.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

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

Figure 2 is a view of a screen upon which the received picture is projected,

Figure 3 is a diagram of a clipping circuit which may be used in the circuit of Fig. 1,

Figure 4 is a circuit diagram of a deflection delay circuit which may be used in the circuit of Fig. 1, and

Figures 5a to 5g are curves which are referred to in explaining the operation of the delay circuit shown in Fig. 4.

Referring to Fig. 1, there is shown a television receiver designed in accordance with my invention, it being assumed that this specific receiver is designed for the reception of a television picture transmitted in a conventional manner wherein sequential scanning and a frame frequency of 30 per second are utilized. It will be understood that in such picture transmission a horizontal synchronizing pulse is produced at the end of each scanning line while a vertical synchronizing pulse is transmitted at the end of each picture frame whereby the picture signal and the synchronizing pulses may be transmitted over the same channel. Preferably the synchronizing pulses are separated from the picture signals in the usual manner by amplitude separation, while the horizontal and vertical synchronizing pulses are separated from each other by means of frequency separation, the vertical synchronizing pulses being of greater duration than the horizontal synchronizing pulses in order to facilitate such separation.

As indicated in Fig. 1, the front end of the receiver may be of conventional design comprising any suitable radio receiver indicated at 10 for amplifying and demodulating the received signal to produce the video signal and synchronizing pulses which are further amplified by a suitable video amplifier 11.

The output of the amplifier 11 is supplied over conductor 12 to a suitable cathode ray receiver tube A which, in the example illustrated, is of the projection type.

Signal from the amplifier 11 is also supplied over a conductor 13 to a suitable picture delay or storage tube 14 and from the delay tube 14 over a conductor 15 to a second cathode ray tube

B which also is illustrated as being of the projection type.

In the example assumed, where the incoming signal has a frame frequency of 30 per second, the delay tube 14 is so operated that it delays the picture signal supplied to the cathode ray tube B one-sixtieth of a second. The reason for producing this delay and the means for obtaining it will be explained in detail hereinafter.

Referring now to the portion of the receiver which controls and produces deflection of the electron beams in the delay tube 14 and in the cathode ray projection tubes A and B, the picture signals and synchronizing pulses are supplied from the video amplifier 11, or from the output of the second detector itself (included in the receiver portion 10), to a suitable separating circuit 17 which, by means of a clipping or limiting action, permits only the synchronizing pulses to appear in its output circuit. It is assumed that the block 17 also includes suitable filtering circuits for separating the horizontal and vertical synchronizing pulses from each other whereby the horizontal synchronizing pulses only are applied to a suitable horizontal deflection circuit 18 and whereby the vertical synchronizing pulses only are applied through a clipping circuit 19 to vertical deflecting circuits 21 and 22.

The clipping circuit 19 is not essential to the circuit operation and, as will appear later, is provided merely to produce a steeper vertical synchronizing pulse, since the pulse supplied by the integrating section of the frequency separation or circuit in the block 17 causes the front edge of the vertical synchronizing pulse to have a very gradual slope.

It will be noted that the vertical synchronizing pulse from the clipping circuit 19 is applied to the vertical deflection circuit 22 through a delay circuit 23 which is so designed that the vertical synchronizing pulse impressed upon the deflecting circuit 22 is impressed thereon one-sixtieth of a second later than the time that the vertical synchronizing pulse is impressed upon the deflection circuit 21. Stated more broadly, the delay which should be provided by the delay circuit 23 is one-half the vertical deflection period. Since in the example taken for the purpose of illustration, the vertical deflection period is one-thirtieth of a second, this means that the delay circuit 23 should provide a delay of one-sixtieth of a second.

It will be apparent from Fig. 1 that the output of the horizontal deflecting circuit 18 produces horizontal scanning of the two electron beams in the delay tube 14 and of the electron beams in the projection tubes A and B in the same time relation. Preferably, saw-tooth deflection is employed both horizontally and vertically, as is customary in the television art. Such deflection may be obtained either by the use of deflecting coils or deflecting plates, although deflecting coils have been indicated in the drawings.

As to the vertical deflection, the electron beam which is in the input or left-hand end of the delay tube 14 and the electron beam in the cathode ray tube A are deflected vertically without delay by the output of the vertical deflection circuit 21.

On the other hand, the electron beam in the output or right-hand end of the delay tube 14 and the electron beam in the cathode ray tube B are deflected with a delay of one-sixtieth of

a second by the output of the vertical deflection circuit 22.

As a result of the above described arrangement, if the pictures appearing on the ends of the cathode ray tubes A and B are projected by means of suitable optical systems indicated at 26 and 27 upon a screen 30, and if they are accurately superimposed on the screen, then during the time the scanning line at the top of the picture is being traced by the tube B, the scanning line at the middle of the picture is being traced by the tube A. Meanwhile, the signal supplied from the delay tube 14 to the tube B has been delayed the correct amount so that the picture applied to the tube B is the signal corresponding to the particular scanning line being traced by the tube B. Thus, at any given point on the projection screen, at the top of the screen, for example, there is started the trace of a new picture frame every one-sixtieth of a second whereby flicker is substantially eliminated even though the picture has been transmitted to the receiver at the rate of 30 frames per second.

Referring more in detail to the delay tube 14, it will be seen that it is a double tube construction in which a highly evacuated envelope contains oppositely disposed electron guns, each of which may be of conventional construction including the usual cathode control electrode, first anode and second anode.

The tube includes the so-called double-sided mosaic indicated at 31 and collecting electrodes 32 and 33 on opposite sides thereof. The collecting rings 32 and 33 may be in the form of rings whereby they may collect secondary electrons from the mosaic 31 without being struck by the electron beams as the mosaic 31 is scanned.

The double sided mosaic screen 31 may be any of several well known constructions. For example, it may be constructed in accordance with the teachings of Patent No. 2,045,984, filed February 28, 1934, in the name of Leslie E. Flory and assigned to the Radio Corporation of America.

Preferably the mosaic 31 is operated slightly positive with respect to the second anode. In the example illustrated, the mosaic 31 is connected to ground while the second anode and the other electron gun electrodes are operated at suitable negative potentials with respect to ground, as indicated. Specific voltages are given on the drawings merely by way of example.

The collecting electrode 32 which may be connected to ground through a resistor 36 functions as the input control electrode while the collector electrode 33 which may be connected to ground through a resistor 37 functions as the signal output electrode.

The operation of the delay tube 14 is substantially as follows: Simultaneously with the scanning of the mosaic 31 by the electron beam produced in the left hand portion of the tube the picture signal is supplied over the conductor 13 and impressed upon the electrode 32 to vary its potential in accordance with the incoming picture signal whereby the individual capacity elements of the mosaic 31 acquire electrostatic charges in accordance with the amplitude of the picture signal. It will be understood that the capacity elements of the mosaic acquire different charges in this manner because the electrode 32 collects more or less secondary electrons from them depending upon its potential.

Thus a picture signal is stored on the mosaic 31 and may be taken off at any time by causing

the electron beam produced in the right hand end of the tube to scan the other side of the mosaic. As this other side of the mosaic is scanned, secondary electrons are released from the mosaic and collected by the electrode 33 whereby the picture signal appears across the resistor 37. It will be understood that this output picture signal is produced because the number of secondary electrons going from a picture or capacity element of the mosaic to the collector electrode 33 depends upon the potential difference between them, this depending upon the charge of the individual picture or capacity element.

As to the construction of the cathode ray tubes A and B, no detailed description is necessary since they may be of conventional construction comprising the usual electron gun consisting of a cathode, a control electrode, a first anode and a second anode. The large end of the tube may have the fluorescent screen coated on its inner surface in the usual manner.

As indicated in Fig. 5a, the vertical deflecting pulse supplied from the synchronizing filter circuit usually has a very gradually sloping front side. Because of this it is desirable to steepen the front side of the impulse by means of the clipping circuit indicated at 19 in Fig. 1 and shown in detail in Fig. 3.

The vertical synchronizing pulse which is shown in Fig. 5a is of negative polarity so that, when applied to the clipping tube 41 (Fig. 3) it is clipped at the level indicated by the dotted line 42. At the input of the second clipping tube 43, the synchronizing pulse is of positive polarity and of sufficient amplitude to drive the tube 43 beyond cut-off, whereby the pulse is clipped at the level indicated by the dotted line 44. The resulting substantially rectangular pulses shown in Fig. 5b are applied to the multivibrator 46 in the delay circuit, as shown in Fig. 4.

By proper adjustment of the multivibrator 46 and, in particular, by adjusting the variable tap 47, the output of this multi-vibrator may have the wave shape shown in Fig. 5c, where positive and negative rectangular pulses are of the same width or duration. Thus, the back side of a positive pulse occurs one-sixtieth of a second later than the front edge of this pulse, as indicated in Fig. 5c.

The output of multivibrator 46 is next differentiated by means of a small-capacity series condenser 48 and a shunt resistor 49, whereby there is produced a voltage wave of the character shown in Fig. 5d. This voltage wave is applied through the coupling condenser 51 to a clipping tube 52 which, as a result of its grid being slightly positive, clips off the positive pulses a substantial amount, whereby the signal appearing in its output circuit is as shown in Fig. 5e. This signal is applied to the clipping tube 53 with sufficient amplitude to drive the tube beyond cut-off, whereby the negative portion of the voltage wave is clipped off, with the result that the signal shown in Fig. 5f is applied to a second multivibrator 54.

It will be apparent that the signal shown in Fig. 5f triggers off the multivibrator 54 one-sixtieth of a second later than the occurrence of the front edge of the pulses applied to the delay circuit 23. Thus, the output of the delay circuit is the voltage wave shown in Fig. 5g and it is this signal that is applied to the vertical deflection circuit 22, whereas the synchronizing signal applied to the vertical deflection circuit 21 is the voltage wave shown in Fig. 5b.

From the foregoing, it will be apparent that the vertical deflection circuit 22 produces vertical deflection of the electron beam in the output end of the delay tube 14 and of the electron beam in the tube B, which is delayed one-sixtieth of a second.

It will be understood that, in the event that the vertical deflecting pulse shown in Fig. 5a is not of sufficient amplitude at the output of the integrating circuit in the unit 17, it may be amplified the necessary amount to obtain the desired clipping in the unit 19.

While a specific form of delay or storage tube has been described, and while specific clipping and delay circuits have also been described, it should be understood that the invention is not limited to the use of these particular units, and that wave shaping circuits and delay circuits or delay apparatus of any other suitable design may be utilized. It will also be understood that, while two separate cathode ray projection tubes have been illustrated by way of example, a single tube having a double gun structure whereby the picture may be viewed directly on the cathode ray tube screen may be employed, if preferred. Furthermore, the invention is not limited to picture reproducing means of the cathode ray type but may be applied in an obvious manner to a television receiver of the type utilizing a light valve and means for scanning a screen with a beam of light.

The invention may be taken advantage of to a still greater extent for effecting an even larger reduction in the frequency band required for the transmission of a given amount of picture detail by superimposing three or more pictures. For example, three cathode ray tubes may be utilized for projecting three superimposed pictures. Assuming the frame frequency has been reduced to 20 per second, one of these pictures will be delayed $\frac{1}{60}$ second while the other delayed picture will be delayed $\frac{2}{60}$ second. The vertical deflections are, of course, delayed a corresponding amount.

The design of a receiver for operating with three superimposed pictures may be similar to that shown in Fig. 1, there being a second picture storage tube for the added cathode ray tube and a second delay circuit for delaying the vertical deflections of the added tubes the required amount.

From the foregoing, it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof.

I claim as my invention:

1. A television receiver for the reception of a picture signal representing a picture sequentially scanned at a certain frame frequency, said receiver comprising cathode ray means for reproducing said picture, a second cathode ray means for reproducing said picture in superimposed relation to said first reproduced picture, a picture storage tube comprising a double-sided mosaic of capacity elements, an electron gun positioned on one side of said mosaic to direct a cathode ray thereupon, an electron gun positioned on the other side of said mosaic to direct a cathode ray upon said other side, means or deflecting the first cathode ray of said storage tube and the cathode ray of the first picture reproducing means at the said frame frequency and in synchronism and in the same time relation, means for so applying picture signals to the storage tube that the scanning of the mosaic by the first cathode ray of the

storage tube causes an electrostatic picture image to be formed on said mosaic, means for taking picture signal from the said other side of the mosaic as it is scanned by the second cathode ray of the storage tube, means for producing a deflecting wave occurring at the picture frame frequency which is delayed with respect to the first-mentioned deflection by an amount equal to one-half the frame period of the received picture, means for applying said delayed deflecting wave to both the storage tube and the second picture reproducing means for deflecting the second cathode ray of the storage tube and the cathode ray of the second picture reproducing means in synchronism and in the same delayed time relation with respect to the first-mentioned deflection, and means for supplying the picture signal taken from said mosaic to the second picture reproducing means.

2. A television receiver for the reception of picture signals representing a sequentially scanned picture recurring at a certain frame frequency, said receiver comprising N picture reproducing means for causing N pictures to appear in superimposed relation on a screen, each of said reproducing means including means for developing a cathode ray and also including deflecting means for causing the cathode ray to be deflected horizontally to form a scanning line across said screen, a picture storage tube comprising a double-sided mosaic of capacity elements, an electron gun positioned on one side of said mosaic to

direct a cathode ray thereupon, an electron gun positioned on the other side of said mosaic to direct a cathode ray upon said other side, means for deflecting the first cathode ray of said storage tube and the cathode ray of the first picture reproducing means at said frame frequency and in synchronism and in the same time relation, means for so applying picture signals to the storage tube that the scanning of the mosaic by the first cathode ray of the storage tube causes an electrostatic picture image to be formed on said mosaic, means for taking picture signal from the said other side of the mosaic as it is scanned by the second cathode ray of the storage tube, means for producing a deflecting wave occurring at the picture frame frequency which is delayed a certain amount with respect to the first-mentioned deflection, means for applying said delayed deflecting wave to both the storage tube and the second picture reproducing means for deflecting the second cathode ray of the storage tube and the cathode ray of the second picture reproducing means in synchronism and in the same delayed time relation with respect to the first-mentioned deflection, and means for supplying the picture signal taken from said mosaic to the second picture reproducing means, the amount of said delay being such that the scanning line representative of the top of the reproduced picture recurs at the top of the screen at a frequency equal to N times the said frame frequency.

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