

April 16, 1946.

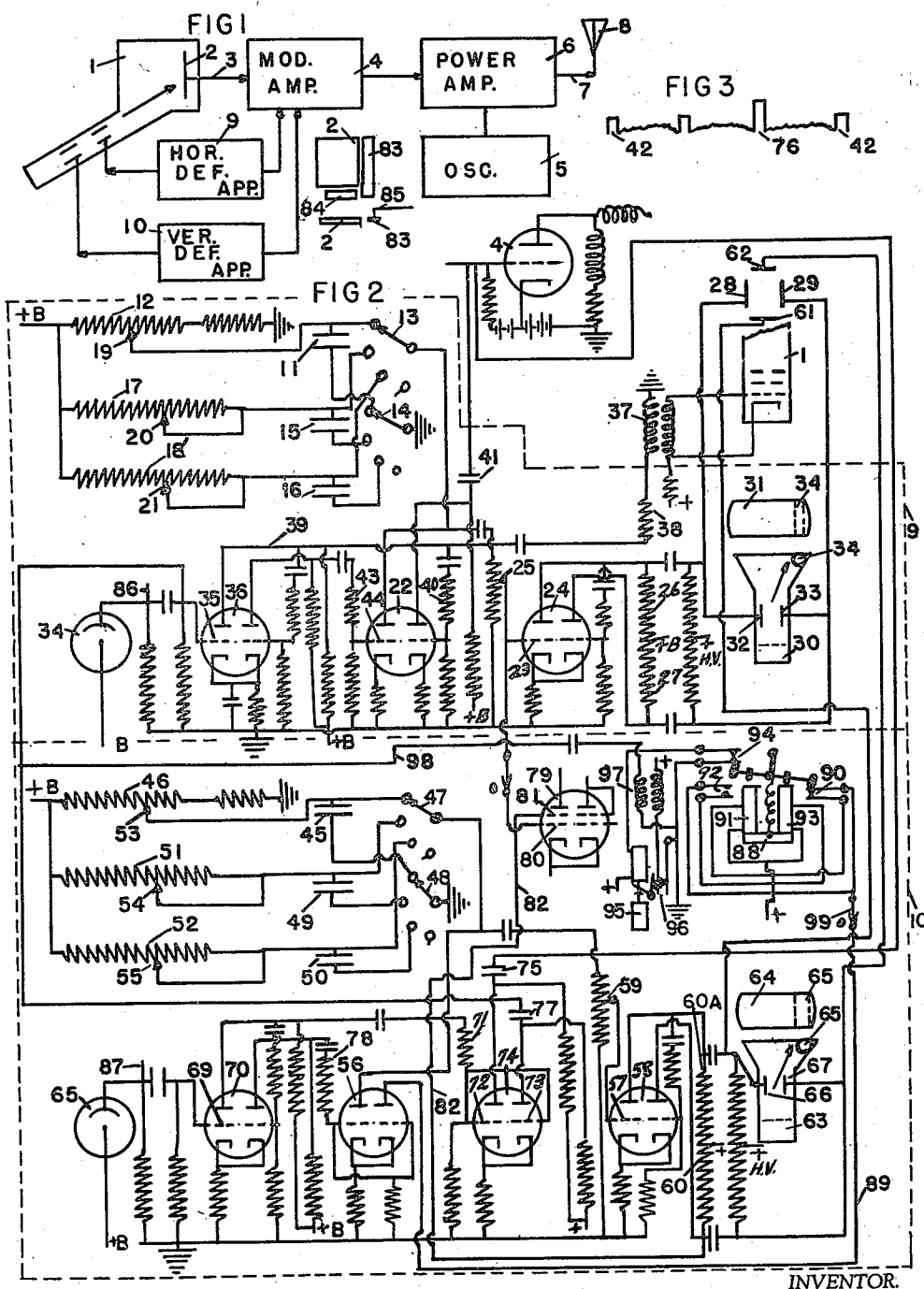
J. H. HOMRIGHOUS

2,398,641

SELF-SYNCHRONIZING TELEVISION SYSTEM

Filed July 21, 1942

2 Sheets-Sheet 1



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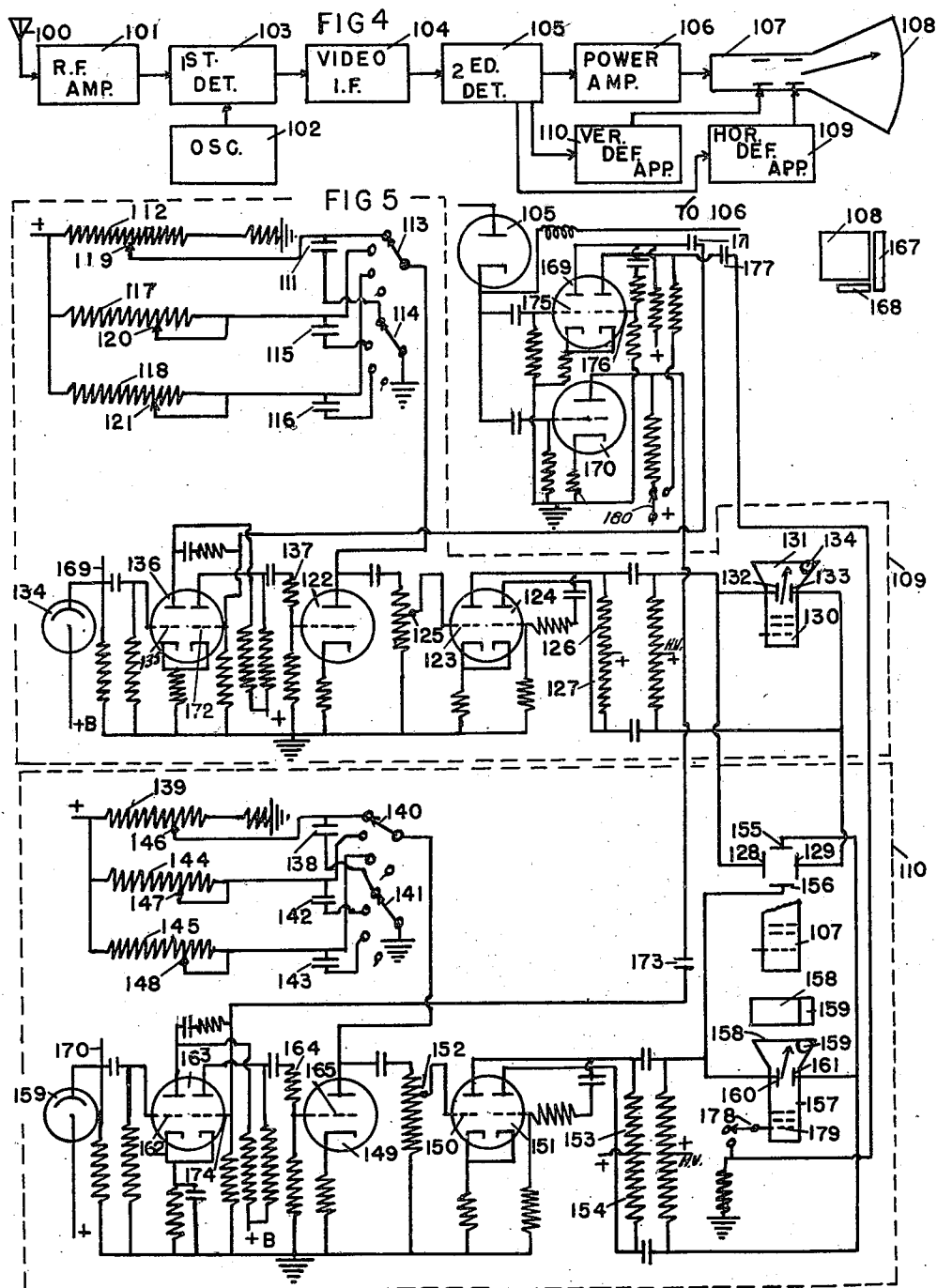
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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SELF-SYNCHRONIZING TELEVISION
SYSTEM

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Application July 21, 1942, Serial No. 451,722

48 Claims. (Cl. 178—69.5)

My invention relates to new and useful improvements in synchronizing the scanning devices used in television, and particularly, a synchronizing system wherein the control signals are transmitted from the transmitter to the receiver during the interval between lines and fields.

Accordingly, one of the main objects of my invention is the provision of means for developing synchronizing or control signals, during the interval between the scanned lines in a field and between the picture fields for controlling the scanning action at the transmitter, and to modulate the carrier with the developed synchronizing or control signals, during the interval between scanned lines and picture fields to thereby govern the scanning action at the receiver.

Another main object of my invention is the self synchronizing feature at the receiver, whereby the line scanning is almost instantly synchronized with the transmitter when placed in service, or after an interruption from fading signals.

Another object is the provision of means for adjusting the number of lines per field, over a wide range.

Another object is the provision of means for adjusting the number of frames in a given time, so that a wide range in the number of pictures per second may be obtained.

Another object of my invention is the provision of means, whereby the receiver may be used for monitoring a television broadcast of any number of pictures per second, and any number of lines per picture, regardless of the type of synchronizing signals used.

Another object of my invention is the provision of means for assuring the continual deflection of the cathode ray beam in the absence of transmitted signals.

Another object of my invention is the provision of means at the receiver for returning the cathode ray to its starting point from any location in the picture.

Another object of my invention is the provision of a new and improved cathode ray tube to initiate the line and frame cut off impulses.

Another object is the provision of an auxiliary cathode ray tube for reproducing the blanking signals as white instead of black and for utilizing the light from this source for controlling the scanning and framing actions.

Several methods for developing and transmitting control frequencies have been devised; for instance, control frequencies have been developed by tuned circuits and transmitted separately from the video frequencies either as a separate modu-

lation on a separate carrier, or in the interval between successive picture fields. In my prior application Serial #306,537, filed Nov. 28, 1939, Patent No. 2,309,393 issued Jan. 26, 1943, control signals are combined with the picture signals in such manner that both are transmitted and reproduced as picture or video signals.

In my present invention, single impulses or control signals are developed at the end of each line and at the end of each picture field, and these signals are modulated on the carrier during the interval between lines and the interval between picture fields to control horizontal and vertical scanning action at the receiving station. These signals are applied at the receiving station to trigger or stop the forward deflection of the cathode ray.

This synchronizing system may be known as "the Follow up System," that is, the receiver is not driven into synchronism but follows the various movements of the transmitter in unison; also, since no tuned circuits are used in developing synchronizing signals this system is very flexible and will respond to a wide range in the number of lines per picture and also a wide range in the number of pictures in a given time.

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

Figures 1 and 4 are simplified diagrammatic views of a television transmitting station and a television receiving station, respectively, illustrating the principles applied in this invention.

Figure 2 is a diagrammatic view of the horizontal and vertical deflecting apparatus illustrated in Figure 1.

Figure 3 is a graphical view showing horizontal and vertical synchronizing impulses.

Figure 5 is a diagrammatic view of the horizontal and vertical deflecting apparatus illustrated in Figure 4.

In Figure 1, the numeral 1 designates a cathode ray scanning device or transmitting tube of conventional type, and is known as an "Iconoscope," and as illustrated it comprises a mosaic 2, photoelectric screen on which a light image of the object is projected and an electron gun for generating a ray of electrons directed at the screen, and two sets of deflecting plates for deflecting the electron ray at the line and field frequencies, so that it is caused to scan the screen. The picture is thereby developed and fed by an output connector 3 to a modulating amplifier 4.

A carrier wave is provided by an oscillator 5.

In the power amplifier 8 this carrier wave is modulated by the frequency band video or picture signals and also by synchronizing impulses from the horizontal deflecting apparatus 9 and the vertical deflecting apparatus 10 between the horizontal lines and between image fields through the modulation amplifier 4. The signals from the amplifier 8 are supplied by a connection 7 to the antenna 8.

The control or synchronizing signals and the video signals are transmitted on the same carrier. Sound signals may be transmitted on a separate carrier or they may be transmitted as video signals as shown in my above mentioned prior application.

With reference to Figure 2 the apparatus 9 for horizontal deflection comprises a condenser 11 charged through an adjustable resistance 12 from a positive potential source as indicated. By movement of the switches 13 and 14, other condensers 15 and 16 may be charged through resistances 17 and 18 respectively from a high positive potential source to supply different predetermined line frequencies for horizontal deflection. Charging current control may also be obtained by varying the resistances through movable contacts 19 or 20 or 21, to give close frequency adjustments.

When the voltage across condenser 11, 15 or 16 builds up, depending upon which switch contacts are closed, the saw tooth voltage wave in the plate circuit of tube 22 is impressed on the grid 23 of double purpose tube 24 through the voltage dividing resistance and a slidable contact 25 for controlling the amplitude of the saw tooth voltage wave. The output of push-pull amplifier tube 24 is applied to the load resistors 26 and 27 to alter the potential on the horizontal deflecting plates 28 and 29 of tube 1 to effect in a well known manner the forward movement of the cathode ray.

To initiate the discharge of condenser 11, 15 or 16 I provide a scanning device or cathode ray tube 30 of conventional type except that it may be of small size, and it may comprise a fluorescence screen or target 31 of rectangular shape, and an electron gun for developing a ray of electrons directed toward the screen. The control electrode of this tube is biased to furnish a constant intensity electron ray. Only one set of electrostatic plates 32 and 33 may be furnished to deflect the electron ray in a forward and backward direction. A small photoelectric cell 34 in a separate glass tube is provided near one edge of the screen. This photo-electric tube may be coated with fluorescence material of rather fast decay.

The plates 32 and 33 are multiplied to the plates 28 and 29 of tube 1 so that the cathode ray in both tubes travel across their respective screens in synchronism. However, should it be desirable to center the electron ray of tube 30 slightly off side, then a separate set of feeders for the deflecting plates should be provided from the load resistances 26 and 27.

When the cathode ray of tube 30 arrives at the edge of the screen having the photocell 34, the change of light in this cell, due to the fluorescence material, will cause a voltage pulse to be applied to the grid 35 of the double triode tube 36. This tube causes three things to occur; first, the signal is amplified in the plate circuit and is then applied to the primary winding 37 of the blanking transformer through resistance 38 and conductor 39 for extinguishing the cathode ray

during its backward movement; second, this same signal is applied through resistance 40 to the grid of tube 22 and amplified in its plate circuit and applied through coupling condenser 41 to the grid of modulation amplifier 4 for modulating the carrier with a positive high potential impulse during retrace as illustrated at 42 in Figure 3; third, the signal is applied in opposite phase to the second grid of tube 36 and amplified in its plate circuit and then applied through resistance 43 to the grid 44 of the trigger tube 22. This tube then becomes conductive to discharge either of the connected condensers 11, 15 or 16.

From the foregoing it will be understood that the photocell 34 causes the cut off or horizontal return trace of the cathode ray, and modulates the carrier with a positive pulse between lines and also extinguishes the electron beam, and furthermore, line frequency may be varied to meet any operating condition.

With further reference to Figure 2, the vertical deflecting apparatus 10 is quite similar to the deflection apparatus 9, and comprises a condenser 45, charged through an adjustable resistance 46 from a positive potential source as indicated. By rotating the switches 47 and 48 other condensers 49 and 50 may be charged through resistances 51 and 52 respectively from a high positive potential source to supply different predetermined frame or picture frequencies. Charging current control may be also obtained by varying the resistance through movable contacts 53, 54 or 55, to give close framing frequency adjustments.

When the voltage across any one of the condensers 45, 49 or 50 builds up the saw tooth wave in the plate circuit of tube 56 is impressed on the grid 57 of tube 58 through the voltage divider resistance and movable contact 59 for controlling the amplitude of the saw tooth voltage wave. The output of the push-pull amplifier tube 58 is applied to the load resistors 60 and 60A to alter the potential on the vertical deflecting plates 61 and 62 of tube 1 to effect the forward movement of the electron ray.

To initiate the discharge of condensers 45, 49, or 50, I provided a scanning device or cathode ray tube 63 of conventional type and exactly like tube 30 previously described having a screen or target 64 and photo-electric cell 65.

The plates 66 and 67 are multiplied to the vertical deflecting plates 61 and 62, respectively, so that the vertical movement of the electron rays across their respective screens will be in synchronism.

When the cathode ray of tube 63 arrives at the edge of the screen having the photocell 65, the change of light caused by the electron ray impinging the fluorescence material will cause a voltage wave to be applied to the grid 69 of the double triode 70. This tube will initiate three conditions; first, the signal is amplified in the plate circuit and is then applied through resistance 71 to the grids 72 and 73 of the double triode tube 74 and amplified in the first plate circuit and applied through the coupling condenser 75 to the grid of modulation amplifier 4 for modulating the carrier with a positive high potential impulse during field retrace as illustrated at 76 Figure 3. The second condition is as follows: the signal amplified in the second plate circuit of tube 74 is applied through coupling condenser 77 to the grid 35 of tube 36 in the horizontal deflecting apparatus 9 to cause, as previously explained, the return of the electron ray to its horizontal

starting position, extinguishing the electron ray in tube 1 and modulating the carrier with a positive high potential in the same phase relation as the impulse from tube 74. The modulation of the carrier with two positive pulses of high potential in phase will produce a greater amplitude than either would alone, as illustrated at 76 Figure 3. The third condition is that the signal as applied to the second grid of tube 70 is amplified in its plate circuit and applied through resistance 78 to the grid of the trigger tube 56. This tube then becomes conductive to discharge the connected condenser 45, 49 or 50.

With certain types of pick up tubes such as that shown at 1 it may be necessary to make corrections in the horizontal deflection for the "Keystone" effect and in order to do this I provide an auxiliary push-pull amplifier tube 79, having a control grid 80, connected to grid 23 of amplifier 24. The plate circuits of this tube are connected to load resistances not shown but similar to 26 and 27. Thence to the deflecting plates 28 and 29 of tube 1 instead of the conductors shown in multiple with the plates 32 and 33, so that the horizontal deflection of tube 1 may be deflected through a changing angle rather than the constant angle of deflection for tube 30. This tube 79 is also provided with a screen grid 81 connected by conductor 82 to the load resistor 60 for varying the potential on the horizontal deflecting plates of tube 1 in accordance with the field deflection.

From the foregoing it will be understood that the photo-cell 65 causes the return of the electron ray both vertically and horizontally to its starting point, modulates the carrier with a positive high potential pulse between fields or picture frames and also extinguishes the electron beam of tube 1, all during the retrace period. Furthermore, line and frame frequency may be varied to meet any operating condition such as 24 or 30 pictures per second, etc. By observing the sweep or otherwise timing the cathode ray in tube 53 it may be adjusted through the variable resistances 46, 51 or 52 and different condensers 45, 49 or 50 to operate at a particular frequency while the amplitude may be adjusted at contact 59 to cut off vertical deflection at any desired number of lines per field.

The mosaic, or screen 2, in Figure 1 may have separate strips of metal, such as aluminum, at the leaving edges for the cathode ray as illustrated at 83 and 84. These strips are shown for clearness on the right side and on the bottom of the mosaic, but due to the lens system of the pick up tube 1, the location of the metal strips may be reversed.

Separate leads may be brought out through the glass tube from these metal strips 83 and 84, such as the lead 85 and connected to the horizontal and vertical deflecting apparatus at 86 and 87 respectively thus replacing the photocells 34 and 65 and also eliminating the tubes 30 and 63.

The operation is as follows: The electron ray is deflected beyond the leaving edges of the mosaic 2 and impinges the plates 83 and 84 to impress an E. M. F. on the tubes 36 and 70. These tubes will operate, as before described, to effect horizontal and vertical scanning actions.

It is to be understood that the photocells 34 and 65 may be placed inside of tube 1 near the cathode ray leaving edge of the mosaic and located as illustrated for the metal plates 83 and 84. These photocells would be coated with fluorescence material of fast decay, thus eliminating

tubes 30 and 63. The operation would be as previously described.

To provide interlace scanning, where the lines of one field fall in between the lines of the previous field, some means for delaying the start of line scanning in alternate fields must be provided since the field retrace control pulse also returns the horizontal movement of the cathode ray to its starting point which will cause the electron ray to travel in almost a straight line during retrace instead of backward and forward across the image screen.

In order to accomplish the above method of interlace, where the number of lines per frame and the number of frames per second may be varied as desired, I employ a double coil toggle action relay 88, which is operated during each vertical retrace period from the second plate circuit of tube 56 over conductor 89, contacts 90, coil 91 to battery thus momentarily energizing the coil 91 to pull armature toward its pole piece where it will remain until coil 93 is again energized. The energization of coil 91 closes the springs 92 to coil 93, and opens the springs 90 and the springs 94. The opening of spring contacts 94 opens the circuit to the dash pot relay 95 which will release to open its springs 96, thus breaking the circuit through the primary winding of transformer 97 which supplies a negative pulse to the grid of the line trigger tube 36 over conductor 98. This negative pulse will have no effect on tube 36. However, the next field control pulse will energize the coil 93 and the armature will be attracted to its pole piece, as shown in the drawings, closing contacts 94 which will energize the slow pull up dash pot relay 95, causing a positive pulse to be applied to the tube 36, thus returning the electron ray to its starting point. Therefore every other field control pulse will cause the horizontal deflection to be stopped and the ray returned to its starting point. The timing device 95 is adjusted to return the electron ray to its starting point at the half way point on the first line in every other field. Therefore it will be understood from the above that the interlace action is positively controlled at the start of each field rather than depending upon the duration of the retrace period after ending the field scanning with a fraction of a line. The switch 99 may be opened for progressive scanning.

With reference to Figure 4, showing a receiving station, the antenna 100 receives the carrier signals from the transmitter antenna 8 to a radio frequency amplifier 101. An oscillator 102 reacts with these signals in the first detector stage 103 on the superheterodyne principle to produce an intermediate frequency which is supplied to the video intermediate frequency stage 104. After suitable amplification the video signal and the control signals are detected at 105 and applied to the power amplifier 106 and after amplification in this tube they are applied to a scanning device 107. The device 107 is represented as being in the form of a cathode ray tube of a conventional type and comprises a fluorescence screen 108, an electron gun for developing a ray of electrons directed at the screen, and two sets of electrostatic plates for deflecting the electron ray at the line and field frequencies to cause it to scan the screen. The video signals are applied to the control electrode of the electron gun, whereby, the intensity of the electron ray is made to vary with the video or picture signals. The horizontal deflecting apparatus 109 receives the line synchronizing impulses from the second detector output

and the vertical deflecting apparatus 110 likewise receives its control signals from the output of the second detector.

With reference to Figure 5, the deflecting apparatuses 109 and 110 are very similar to that described for the transmitter. The apparatus 109, for horizontal deflection at the receiver, comprises a condenser 111 charged through a variable resistance 112 from a positive potential source as indicated. By adjusting the switches 113 and 114 other condensers 115 and 116 may be charged through resistances 117 and 118 respectively from a high positive potential source to supply different predetermined line frequencies for horizontal deflection. Charging current control may be obtained by varying the resistance through movable contacts 119, 120 or 121, to give close frequency adjustments.

When the voltage across condensers 111, or 115 or 116, depending upon which switch contacts are used, builds up, the saw tooth voltage waves in the plate circuit of tube 122 are impressed on the grid 123 of double purpose tube 124 through a voltage dividing resistance with a slidable contact 125 for controlling the amplitude of the saw tooth voltage waves. The output of the push-pull amplifier tube 124 is applied to the load resistance 126 and 127 to change the potential on the horizontal deflecting plates 128 and 129 of tube 107 to effect the forward movement of the cathode ray.

To initiate the discharge of condensers 111, 115 or 116 in the absence of signal I provide an auxiliary scanning device or cathode ray tube 130 of conventional type and exactly like tube 30 previously described, and may comprise a fluorescence screen 131 of rectangular shape, one set of electrostatic plates 132 and 133, multiplied to the plates 128 and 129 respectively, and a small photoelectric cell 134 in a small glass tube near one edge of the screen. A separate set of feeders to the deflecting plates 132 and 133 may be provided, if it is desired to shift the center of the lines scanned on the screen.

When the cathode ray of tube 130 reaches the photocell 134, the change of light in this cell, due to the fluorescence material, will cause a voltage pulse to be applied to the grid 135 of tube 136 after suitable amplification and a phase reversal in tube 136 the signal is applied to the grid of the trigger tube 122 through resistance 137. This tube then becomes conductive to discharge either of the condensers 111, 115 or 116.

With further reference to Figure 5, the vertical deflecting apparatus 110 is very similar to the horizontal deflecting apparatus and comprises a condenser 138, charged through a variable resistance 139 from a positive potential source as indicated. By rotating the switches 140 and 141 other condensers 142 and 143 may be charged through resistances 144 and 145 from a positive potential source to thereby supply different predetermined frame or picture frequencies. Charging current control may also be obtained by varying the resistance through movable contacts 146, 147, or 148 to give close frame frequency adjustments.

When the voltage, across any one of the condensers 138, 142 or 143, builds up the saw tooth wave in the plate circuit of tube 149, is impressed on the grid 150 of tube 151 through the resistance and movable contact 152 for controlling the amplitude of the saw tooth voltage wave. The output of the push-pull amplifier tube 151 is applied to the load resistances, 153 and 154

to increase and decrease the potential on the vertical deflecting plates 155 and 156 of tube 107 to effect the vertical movement of the electron ray.

To initiate the discharge of condenser 138, 142 or 143 in the absence of control signals I provide an auxiliary scanning device or cathode ray tube 157 of conventional type and exactly like the tube 130 described above, having a screen 158 and a photoelectric cell 159. The plates 160 and 161 are multiplied to the plates 155 and 156 so that the vertical movement across their respective screens will be in synchronism.

When the cathode ray of tube 157 is deflected until it strikes the photocell 159, the change of light on the photocell will cause a voltage wave to be applied to the grid 162 of the double triode 163; after suitable amplification and a phase reversal in tube 163, the signal is applied through resistance 164 to grid 165 of the trigger tube 149. The tube 149 then becomes conductive to discharge one of the connected condensers 138, 142 or 143.

From the foregoing, it will be understood that in the absence of signals, due to fading, or in turning the receiver on where there is no transmitter operating, that the cathode ray will oscillate both horizontally and vertically.

The tube 107, Figure 4, may have on one side and on the bottom of the screen metal strips 167 and 168 with separate leads brought out through the glass envelope. The strip 167 may be connected to the horizontal apparatus at 169, replacing the photocell 134, and the strip 168 may be connected to the vertical deflecting apparatus at 170, replacing the photocell 159.

The operation is as follows: The electron ray is deflected to impinge the plate 167 at the end of each line and to impinge the plate 168 at the end of each field to impress an E. M. F. on the grids of the tubes 136 and 163 respectively, which will operate the horizontal and vertical deflecting apparatus as described above.

The tube 107 may have the photocells 134 and 159 placed inside the envelope, close to the outer edges of the screen and as illustrated for the plates 167 and 168. The operation would be the same as above described.

The video and control signals are demodulated at the second detector or rectifying tube 105 and applied to the power amplifier 106, and after suitable amplification in the power amplifier 106 they are applied to the control grid of the viewing tube 107. Since the control or synchronizing signals are of a higher amplitude than the picture signals and appear at the end of each line and at the end of each field, they may be used to blank or reduce the intensity of the cathode ray in the viewing tube during the retrace period.

The video and control signals from detector tube 105 are also applied to the grids of tubes 169 and 170. The tube 169 for controlling the horizontal deflection period is biased so that the picture signals will not produce plate current, but it does respond to both the line and field synchronizing pulses to thereby apply a voltage impulse through the coupling condenser 171 to the grid 172 of tube 136. After suitable amplification in its plate circuit the signal is applied to the trigger tube 122 to operate the horizontal deflecting apparatus, as previously described, to return the electron ray of tube 107 to its starting point.

The tube 170 is biased to eliminate both the picture signals and the horizontal synchronizing

impulses, but it will respond to the high amplitude field synchronizing pulse to impress a potential impulse through coupling condenser 173 to the grid 174 of tube 163. This tube will function as previously described to return the cathode ray to the starting point of the next field.

From the foregoing it is to be understood that the cathode ray in the viewing tube will be returned either to its horizontal or horizontal and vertical starting point from any location on the screen upon the reception of a control or synchronizing signal. In other words, the horizontal control signals will return the electron beam to the starting point for the next line, and the vertical control signal will return the electron ray to the starting point of the first line in the next succeeding field.

The amplitude for the horizontal and vertical deflection is adjusted by the movable contacts 123 and 152 so that the ray will reach the photocells 134 and 159 or the metal plates 167 and 168, depending upon which system is used.

The operation of the receiver is as follows: When the receiver is energized, upon closing the power supply circuit the cathode ray will oscillate or travel forward and backward horizontally and vertically by developing deflecting potentials across condensers and discharging these condensers through the action of the cut off devices 130 and 157 or 167 and 168. However, upon the reception of synchronizing signals, interposed between lines and between picture fields, the line deflecting apparatus will function upon the reception of the first horizontal control pulse to return the cathode ray to start the next line in synchronism with the transmitter. Upon the reception of the first vertical control pulse the vertical deflecting apparatus will operate to return the electron ray to start the first line of the next succeeding field. Therefore the receiver will be automatically synchronized with the transmitter upon the reception of the first vertical synchronizing pulse, and the line deflection will be in step with the transmitter upon the reception of the first horizontal control pulse.

Synchronism is accomplished by transmitting a control pulse during each retrace period of the cathode ray in the pick up tube and utilizing this control pulse at the receiver to return the cathode ray in the viewing tube to the starting point of the next forward movement.

The devices 130 and 157 or 167 and 168 may be considered primarily as safety devices so that the cathode ray will continue to oscillate should the signals fade, or the transmitting station go off the air. With the reception of strong signals these devices do not operate.

The receiver may be operated from any combination of lines and picture fields and different transmitting stations may use different frequencies. The switches 113 and 114 for selecting horizontal frequencies and the switches 140 and 141 for selecting vertical frequencies may be used to obtain the required frequency. The proper combination of resistance and capacity should be used so that the cathode ray will be cut off just short of the safety devices 134 and 159 or 167 and 168. The receiver running more slowly than the transmitter will cause the cathode ray to be returned before reaching the full size of the tube and the picture would be smaller than necessary.

The receiver may be used for monitoring on other television systems. By utilizing the blanking signals which are of higher amplitude than the picture signals, the blanking signals at end of

each line would supply a voltage wave to the grid 175 of tube 169 which would cause the horizontal deflecting apparatus to function as before described. By the operation of switch 180, tube 170 is rendered inoperative and the right plate circuit of tube 169 is supplied with positive potential. The blanking signals would also be applied to the second grid 176 of tube 169 after suitable amplification in its plate circuit the signal would be applied through coupling condenser 177 and the switch 178 to the control grid 179 of the cathode ray cut off tube 157. Due to the phase reversal in tube 169 the blanking signals will now appear as white on the fluorescence screen of tube 157 which will cause a voltage wave to be applied to the grid 182, when the cathode ray impinges the photo cell 159. The vertical deflecting apparatus will function as before described to return the cathode ray in the viewing tube 107 to its starting position.

From the foregoing it is to be understood that this receiver may be used for the reproduction of television signals from transmitters using various synchronizing methods.

In the various circuits shown and described I have simplified the drawings by indicating the source of potential by a positive or negative sign. Also I have omitted the heater filaments for the various tubes, but it will be understood that such filaments would be necessary.

The embodiments of the invention which have been given herein are illustrations of how the various features may be accomplished and of the principles involved. It is to be understood that the invention contained herein is capable of embodiment in many other forms and adaptations, without departing from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In a television system, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for moving the said electron ray in forward and backward directions to scan said image plate, an auxiliary scanning device, means including said device for initiating the backward movement of the said electron ray and for controlling its intensity during its backward movement.

2. In a television system, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for moving the said electron ray in forward and backward directions to scan said image plate, means for developing picture signals during the forward movement of said ray, an auxiliary scanning device, means including said device for developing control signals, means associated with said tube responsive to the said control signals for initiating the backward movement of the said electron ray, and means for transmitting the said picture signals and the said control signals alternately.

3. In a television system, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for moving the said electron ray in vertical directions, forward during field periods and backwards during vertical retrace, means for moving the said electron ray in horizontal directions, forward to scan line locations on said image plate during said field periods, and backwards during line retrace, a horizontal auxiliary scanning device, means including said device for initiating the backward horizontal movement of the said electron ray, a vertical auxiliary scanning device, and

means including the said vertical scanning device for initiating the backward vertical movement of the said electron ray.

4. In a television system, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for moving the said electron ray in vertical directions, forward during field periods and backwards during vertical retrace, means for moving the said electron ray in horizontal directions, forward to scan line locations on said image plate during said field periods, and backwards during line retrace, a horizontal auxiliary scanning device, means including said device for initiating the backward horizontal movement of the said electron ray, a vertical auxiliary scanning device, and means including the said vertical scanning device for initiating the vertical and horizontal backward movements of the said electron ray.

5. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, means for moving the said electron ray in vertical directions, forward during field periods and backwards during vertical retraces, a vertical control device, means including said device for developing vertical synchronizing signals, means for moving the said electron ray in horizontal directions, forward to scan line locations on said image plate during said field periods, and backwards during line retrace, a horizontal control device, means including said horizontal control device for developing horizontal synchronizing signals, means responsive to the said horizontal synchronizing signals for initiating the backward horizontal movement of said electron ray, and for controlling its intensity during its backward movement, means responsive to the said vertical synchronizing signals for initiating both the vertical and horizontal backward movements of the said electron ray, means for developing picture signals during the forward horizontal movement of the said electron ray, and means for transmitting the said picture signals, and the said horizontal synchronizing signals alternately; and for transmitting the vertical synchronizing signal at the end of each field period.

6. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, vertical deflecting means for controlling the movement of said electron ray in vertical directions during field periods, horizontal deflecting means including line signals for controlling the movement of said electron ray in horizontal reciprocating directions to successively scan line locations on said image screen, and means for returning the electron ray to its starting point from substantially the midpoint of the first line in alternate field periods under the control of said line signals, to thereby scan even line locations on said image screen during alternate field periods.

7. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, vertical deflecting means for controlling the movement of said electron ray in vertical directions during field periods, horizontal deflecting means for controlling the movement of said electron ray in horizontal reciprocating directions to successively scan line locations on said image screen, a slow-acting mechanism, and means including the said mechanism for advancing the starting time for the second horizontal line in alternate field periods to thereby scan even line locations on said image screen during alternate field periods.

8. The system, in accordance with claim 5, in which there is provided means to vary the number of line locations that may be scanned on the said image screen during the said field periods, and to change the intervals between the said horizontal synchronizing signals.

9. The system, in accordance with claim 5, in which there is provided means to vary the number of image fields, that may be scanned in a given time, and to change the periodicity of the said vertical synchronizing signals.

10. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, deflecting means for moving said electron ray in vertical and horizontal directions to scan said image screen, means for intercepting incoming horizontal and vertical synchronizing impulses having unequally spaced periods, means for utilizing said horizontal impulses to initiate backward horizontal movements of said electron ray from substantially a mid portion of said screen and from one edge of said screen, and means actuated by said vertical impulses to simultaneously initiate a vertical backward movement and horizontal backward movement of the electron ray.

11. The system, in accordance with claim 10, in which there is provided means actuated by the said deflecting means for initiating the backward movement of the said electron ray in the absence of synchronizing impulses.

12. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, vertical deflecting means for moving the said electron ray forward vertically during field periods of time and backward vertically during retrace, horizontal deflecting means for moving the said electron ray forward horizontally to successively scan line locations on said image screen during field periods, and backward horizontally during retrace, means for intercepting incoming vertical synchronizing impulses and horizontal synchronizing impulses, suitable circuits and apparatuses for utilizing said vertical synchronizing impulses to cause the vertical deflecting means and the horizontal deflecting means to reverse the movements of the said electron ray both vertically and horizontally, certain of said circuits and apparatuses responsive to the said horizontal synchronizing impulses to cause the horizontal deflecting means to reverse the backward horizontal movements of the said electron ray upon reaching one side of said screen and from a mid-location on said screen to cause the electron ray to scan lines in one field different than the lines scanned in the previous field.

13. The system, in accordance with claim 12, in which there is provided switching means for varying the number of line locations scanned during field periods, and switching means for changing the number of field periods in a given time.

14. In a television system, a cathode ray tube having an image screen and an electron ray directed toward the image screen, vertical deflecting means for moving the said electron ray forward vertically during field periods of time and backward vertically during retrace, horizontal deflecting means for moving the said electron ray forward horizontally to successively scan line locations on said image screen during field periods, and backward horizontally during retrace, means for intercepting picture signals and control impulses alternately, apparatuses and suitable circuits for utilizing the said control impulses to cause the horizontal deflecting means to reverse

the horizontal movement of the said electron ray between interception of the said picture signals and from intermediate positions on said screen in certain recurring field periods, means for identifying and redeveloping one of said control impulses at the end of each image field and to apply the redeveloped impulses to other apparatuses and associated circuits to cause the vertical deflecting means to initiate the backward vertical movement of the said electron ray.

15. In a television transmitter for modulating a carrier wave with control signals, a cathode ray camera tube having a mosaic image plate and an electron ray directed toward the image plate, means for moving the said electron ray in forward and backward directions to scan line locations on said image plate in successive fields, means driven by said first means for developing said control signals to modulate said carrier wave and to initiate the backward movement of said ray, and means responsive to certain of said control signals for causing the electron ray to scan different line locations on said image screen in alternate and intermediate fields.

16. In a television transmitter for modulating a carrier wave with signaling impulses, a cathode ray tube having an image plate and an electron ray directed toward the image plate, deflecting means for moving the said electron ray forward during trace periods to scan line locations on said plate in successive fields and backward during retrace periods, means for developing picture signals during trace periods, means controlled by said deflecting means for developing signalling impulses at end of each trace period to modulate said carrier wave, means responsive to said impulses for initiating the retrace periods, and means responsive to certain of said impulses for causing the electron ray to scan different line locations on said image screen in alternate and intermediate fields.

17. In a television transmitter, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, a signalling device for producing signalling impulses, comprising a cathode ray tube having a target with a photo electric cell at one end of the target and an electron ray directed toward the target, means for moving both of said rays forward in unison to scan the said image plate in the camera tube, and to increase the intensity of light on the said photo electric cell in the said device, to thereby produce a signalling impulse for initiating the backward movement of both of the said rays.

18. In a television transmitter, a line and frame scanning device, means for producing picture signals during recurring line trace periods, and means operating in unison with the said device for producing scanning control impulses in the interval between line trace periods, one impulse for each interval to control the line scanning actions and the last control impulse in each frame to also control the frame scanning actions in the said scanning device.

19. In a television transmitter, a cathode ray camera tube having a mosaic image plate and an electron ray directed toward the image plate, means for moving the said electron ray forward and backward horizontally, and forward and backward vertically to scan line locations on the said image plate in successive fields, means for developing line control signals to initiate the horizontal backward movement of said ray, means for developing frame control signals to initiate both the vertical and horizontal backward movements

of said ray, and means responsive to certain of the said line control signals for causing the electron ray to scan different line locations on said image plate in alternate and intermediate fields.

20. In a television transmitter, means for developing picture signals during relatively short and relatively long spaced periods of time, means for developing a line or a combined line and frame control signal during each interval between said periods with a relatively short period appearing after each alternate combined signal, said line control signals occurring a greater number of times per second than the combined line and frame control signals, and means for transmitting the said picture signals and the said control signals alternately.

21. In a television system, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for moving the said electron ray forward and backward horizontally, and forward and backward vertically to scan line locations in successive fields on the said image plate, means for producing periodically recurring control signal impulses; each impulse to initiate the backward movement of said ray both vertically and horizontally, and means for causing the electron ray to scan different line locations on said image plate in alternate and intermediate fields.

22. In a television transmitter, a cathode ray tube having an image screen and an electron ray directed toward the image screen, means for moving the said electron ray forward and backward horizontally to scan a line on said screen, means for moving the said electron ray forward and backward vertically during spaced periods of time to cause different lines to be scanned on said screen, means for causing said electron ray to scan odd and even lines on said screen in alternate and intermediate periods respectively, means for developing control signal impulses, and means for driving the electron ray backward to a common starting point on said screen for each picture frame under the control of said signals.

23. In a television transmitter, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for deflecting the said electron ray forward and backward horizontally, and forward and backward vertically to scan lines in successive fields on the said image plate, means driven by said deflecting means for producing vertical control impulses to initiate the backward movements of said ray both vertically and horizontally, means for developing line control impulses, and means responsive to certain of said line control impulses for causing the electron ray to scan different line locations on said image plate in alternate and intermediate fields.

24. In a television transmitter, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for deflecting the said electron ray forward and backward horizontally and forward and backward vertically to scan lines in successive fields on the said image plate, means driven by said deflecting means for producing horizontal and vertical control impulses to initiate the backward movements of said ray, the horizontal control impulses initiating the horizontal backward movement, and the vertical control impulses initiating both the vertical and the horizontal backward movements of the said ray, and means responsive to certain horizontal control impulses for causing the electron ray to scan lines on said image plate in one field

different from the lines scanned in the previous field.

25. In a television transmitter, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for deflecting the said electron ray forward and backward horizontally, and forward and backward vertically to scan lines in successive fields on the said image plate, means for producing control impulses, means associated with said tube responsive to the said control impulses for initiating the backward movement of said ray both vertically and horizontally, means for changing the frequency of occurrence of said impulses to change the number of fields in a given time, and means for causing the electron ray to scan odd and even lines on said image plate in alternate and intermediate fields respectively.

26. In a television transmitter, a cathode ray camera tube having an image plate and an electron ray directed toward the image plate, means for deflecting the said electron ray forward horizontally, and forward vertically to scan the said image plate, means for producing relatively low, and relatively high amplitude control impulses, means for deflecting the electron ray backward horizontally under the control of said low amplitude impulses, and means for deflecting the electron ray backward both vertically and horizontally under the control of said high amplitude impulses.

27. In a television transmitter, a cathode ray camera tube having a screen and an electron ray directed toward the screen, means for deflecting the said ray in horizontal and vertical directions forward and backward to scan lines in successive fields on said screen, an impulse generator device controlled by said means for producing control impulses to initiate the horizontal backward movement of said ray, another impulse generator device controlled by said means for producing other control impulses to initiate both the horizontal and vertical backward movements of said ray at the same time, means for causing the electron ray to scan lines on said screen in one field different from the lines scanned in the previous field, and means for adjusting the said first means to change the frequency of occurrences of said impulses to thereby change the number of forward and backward movements of the electron ray in a given time.

28. In a television transmitter, a cathode ray camera tube having a screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward to scan line locations on said screen, an impulse generator comprising a cathode ray tube having a screen with a light sensitive device at one end of the screen and an electron ray directed toward the screen, said deflecting means also for deflecting the electron ray in the said impulse generator tube in unison with the electron ray in the said camera tube to impinge the light sensitive device thereby producing control impulses, means responsive to said impulse for initiating the backward movement of said rays, and means for adjusting the said deflecting means to change the interval of time required for the forward movement of said rays thereby changing the number of line locations scanned in a given time and also changing the frequency of occurrence of said impulses.

29. In a television transmitter, a cathode ray tube having an image screen and an electron ray directed toward the screen, an impulse generator

comprising a cathode ray tube having a screen with a light sensitive device at one end of the screen and an electron ray directed toward the screen, means common to both tubes for deflecting both electron rays forward and backward across their respective screen in unison, said electron ray in the camera tube for scanning line locations on the said image screen, and the said electron ray in the impulse generator tube for impinging the said light sensitive device to thereby produce control impulses at the ending of each line at the edge of the said image screen, means responsive to the said impulses for initiating the backward movement of both of the rays, and means for adjusting the said deflecting means to change the interval of time required for the forward movement of both rays, thereby changing the number of line locations scanned in a given time and also changing the interval between successive impulses.

30. In a television transmitter, a cathode ray camera tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward during frame periods and backward during retrace periods to scan the said screen, an impulse generator comprising a cathode ray tube having a screen with a light sensitive device at one end of the screen and an electron ray directed toward the screen, said deflecting means also for deflecting the electron ray in the said impulse generator tube in unison with the electron ray in the said camera tube to impinge the light sensitive device thereby producing control impulses, means responsive to said impulses for initiating the backward movement of the said rays, and means for adjusting the said deflecting means to change the interval of time required for the frame periods thereby changing the number of frames scanned in a given time and also changing the interval between successive impulses.

31. In a television transmitter, a cathode ray tube having an image plate and an electron ray directed toward said plate, means for deflecting the said ray forward and backward to scan line locations on said screen, means for deflecting the said ray forward and backward vertically to scan image fields, means for producing control impulses to initiate the vertical backward movement of the said ray, and means responsive to the said impulse for producing a second control impulse to initiate the horizontal backward movement of said ray at substantially the mid point of the first line in the image field.

32. In a television transmitter, a cathode ray tube having an image plate and an electron ray directed toward said plate, means for deflecting the said ray forward and backward to scan line locations on said screen, means for deflecting the said ray forward and backward vertically to scan image fields, means for producing control impulses to initiate the vertical backward movement of the said ray, a relay responsive to the said impulses to close a pair of contacts during alternate field periods, and means responsive to the closing of the said contacts for producing a second control impulse to initiate the horizontal backward movement of said ray at substantially the mid point of the first line in alternate image fields.

33. In a television transmitter, a cathode ray tube having an image plate and an electron ray directed toward said plate, means for deflecting the said ray forward and backward to scan line locations on said screen, means for deflecting the said ray forward and backward vertically to scan

image fields, means for producing control impulses to initiate the backward movement of the said ray, and means responsive to the said impulses for initiating the horizontal backward movement of said ray at substantially the mid point of the first line in the image field.

34. In a television transmitter, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward to scan line locations on said screen, means for deflecting the said ray forward and backward vertically to scan image fields, means for producing control impulses to initiate the vertical backward movement of the said ray, means responsive to said control impulses for producing signalling impulses during alternate field periods and a device responsive to the said signalling impulses to initiate the horizontal backward movement of the said ray at substantially the mid point of the first line in alternate image fields.

35. In a television transmitter, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward to scan line locations on the said screen, a scanning control device for producing control impulses to initiate the backward movement of said ray, means for deflecting the said ray forward and backward vertically to scan image fields, means for producing vertical control impulses to initiate the backward movement of the said ray both vertically and horizontally, means responsive to the said vertical control impulses for producing signalling impulses during alternate field periods, and means responsive to the said signalling impulses for returning the said ray from substantially the mid point of a line to the starting point for the next line.

36. The system in accordance with claim 35 in which there is provided means for utilizing the said control impulses to control the intensity of the said electron ray during its backward movement.

37. In a television transmitter, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward to scan line locations on the said screen, a scanning control device for producing control impulses to initiate the backward movement of said ray, means for deflecting the said ray forward and backward vertically to scan image fields, means for producing vertical control impulses to initiate the backward movement of the said ray both vertically and horizontally, means responsive to the said vertical control impulses for producing signalling impulses during alternate field periods, means responsive to the said signalling impulses for producing line control impulses to initiate the horizontal backward movement of said ray from substantially the mid point of a line to the starting point for the next line, and means for transmitting said line and vertical control impulses.

38. In a television receiver, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward horizontally and vertically to scan lines in successive fields on said screen, means for intercepting line, and frame control impulses, means responsive to the line control impulses for stopping the horizontal forward movement of said ray and for causing the lines in one field to be in between the lines in the next succeeding field, and means responsive to the frame control impulse for stopping both

the vertical and horizontal forward movements of said ray.

39. In a television receiver, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward horizontally and vertically to scan line locations in successive image fields, means for intercepting line and frame control signals, means responsive to the said line control signals for stopping the line forward movement of said ray and for causing the lines in one field to be between the lines in the next succeeding field, and means responsive to each frame control signal for stopping the line, and the frame forward movements of said ray.

40. In a television system, a transmitting station, a scanning device at said transmitting station, comprising a cathode ray tube having an image plate and an electron ray directed toward the plate, means for deflecting said ray both horizontally and vertically to scan lines in successive frames in said plate means for producing line, and frame control signals, the line control signals for reversing the line scanning actions, and the frame control signals for reversing both frame and line scanning actions in the said device, means for transmitting the said control signals, a receiving station, a scanning device at said receiving station comprising a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting said ray both horizontally and vertically to scan lines in successive frames on said screen, means responsive to received line control signal for reversing the line scanning actions from any advanced position, and means responsive to each receiving frame control signal for reversing both the line and frame scanning actions in the scanning device at the said receiver station in unison with the scanning actions at the said transmitting station.

41. In a television receiver, a cathode ray tube having an image screen and an electron ray directed toward the image screen, means for deflecting said ray forward and backward horizontally and vertically to scan lines in successive fields on said screen, means for intercepting incoming horizontal, and vertical control signals, means responsive to the said horizontal signals for reversing the horizontal deflection of said ray and for causing the electron ray to scan lines in one field different than the lines scanned in the previous field, and means actuated by the said vertical signals for reversing both the horizontal and vertical deflection of said ray.

42. In a television receiver, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward horizontally and vertically to scan said screen, means for intercepting incoming line and frame control signals, means for deflecting the electron ray backward at the end of each line and at least once from the mid position in a line in alternate fields under the control of said line signals, and means for driving the electron ray backward both vertically and horizontally under the control of said frame signals.

43. In a television receiver, a cathode ray tube having an image screen and an electron ray directed toward the screen, means for deflecting the said ray forward and backward horizontally and vertically to scan said screen, means for intercepting relatively low, and relatively high amplitude control impulses, means responsive to the relatively low amplitude impulses for stopping the

forward horizontal deflection of said ray and for causing the electron ray to scan lines in one field different than the lines scanned in the previous field, and means responsive to the relatively high amplitude impulses to stop the vertical and horizontal forward deflection of said ray.

44. In a television receiver, a cathode ray tube provided with a screen and an electron ray directed toward said screen, means for deflecting the electron ray forward horizontally and vertically to scan lines on said screen to produce picture images from received picture signals, and means for deflecting the electron ray backward at the end of each line and at least once from the mid position in a line in alternate fields under the control of received line control impulses.

45. The method of transmitting pictures of a scene within the view of the transmitter comprising a line and frame scanning device for developing picture signals during line trace periods in reciprocating scanning actions, a generator for developing line and frame control signals, utilizing said line control signals to reverse line scanning actions, and utilizing the frame control signals to reverse both line and frame scanning actions in said scanning device to transmit said control signals along with the said picture signals.

46. The method of producing picture images from received video signals, unequally spaced line, and line and frame control signals comprising a line and frame scanning device for developing picture images from said video signals during line

trace periods in reciprocating scanning actions, utilizing the said line control signals to reverse line scanning actions after either a full trace period or substantially one half of a trace period, said half trace period causing said electron ray to scan odd and even lines in alternate and intermediate frames respectively and utilizing the said line and frame control signals to reverse both the line and frame scanning actions.

47. The method of producing picture images from received video signals, unequally spaced line, and line and frame control signals comprising a line and frame scanning device for developing picture images from said video signals during line trace periods in reciprocating scanning actions, utilizing each line control signal received to reverse the line scanning action either at the edge of said screen or at substantially the mid point of said screen, the mid point reversal causing said ray to scan odd and even lines in alternate and intermediate frames respectively, and utilizing each line and frame control signal received to reverse both line and frame scanning actions.

48. In a radio system, a radio station, a pair of generators at said station for producing two sets of saw tooth waves comprising a first means for producing control signals to terminate the waves in one of said sets and a second means for producing other control signals to terminate the waves in both of said sets simultaneously.

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