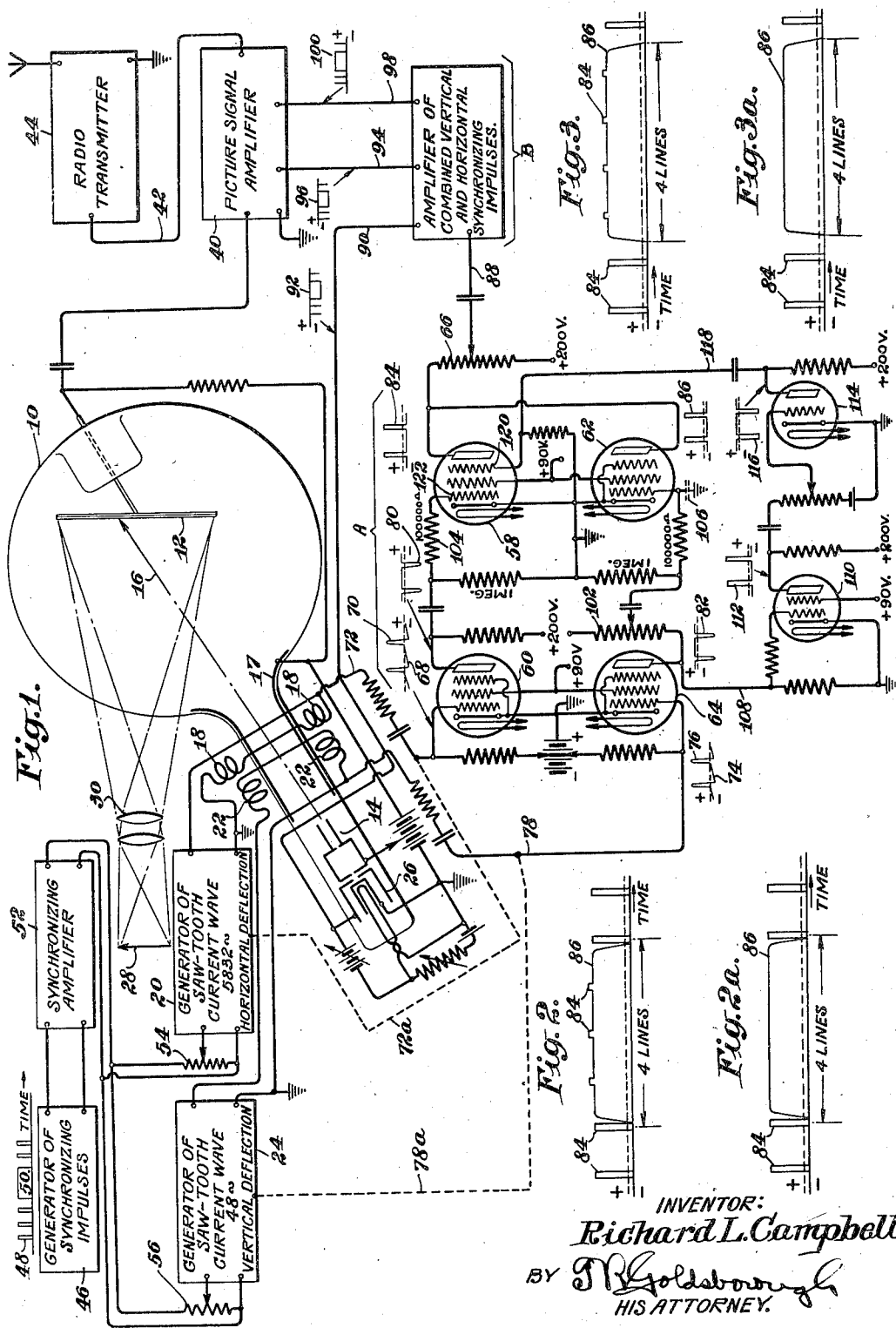


March 15, 1938.

R. L. CAMPBELL
TELEVISION SYSTEM

2,110,982

Original Filed June 1, 1933 2 Sheets-Sheet 1



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Fig. 5.

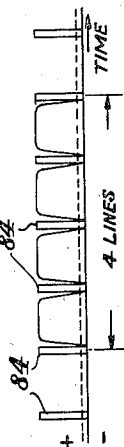


Fig. 6.

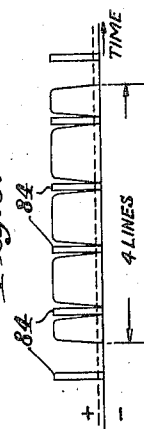
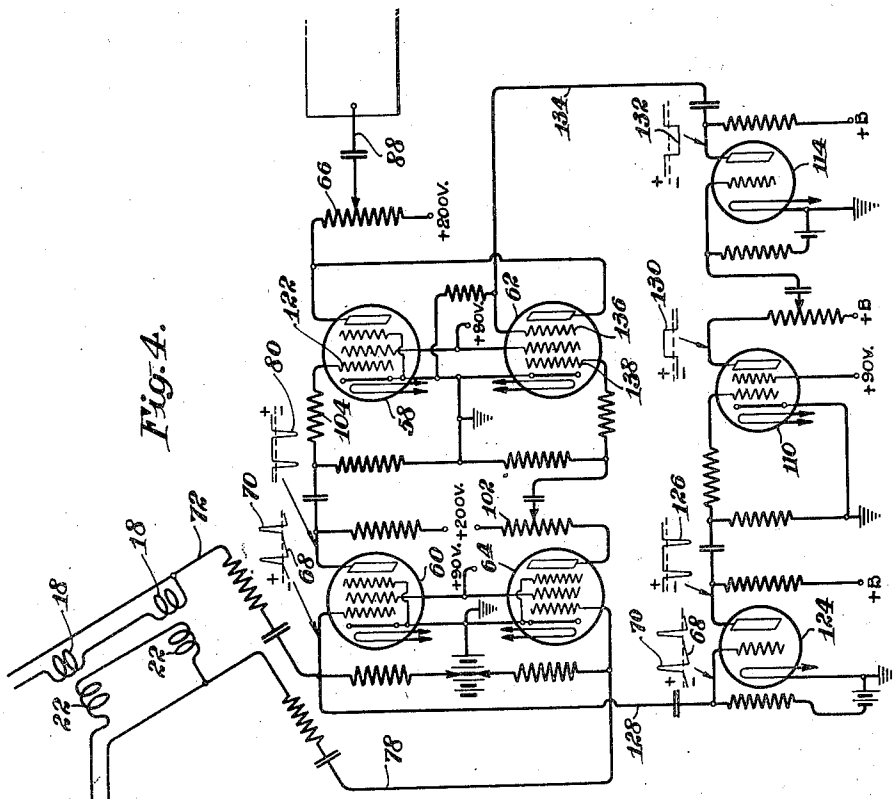


Fig. 4.



INVENTOR:

Richard L. Campbell,

BY *DR Goldborough*
HIS ATTORNEY.

UNITED STATES PATENT OFFICE

2,110,982

TELEVISION SYSTEM

Richard L. Campbell, Oaklyn, N. J., assignor to
Radio Corporation of America, New York, N. Y.,
a corporation of Delaware

Application June 1, 1933, Serial No. 673,833
Renewed August 6, 1937

14 Claims. (Cl. 178—7.1)

My invention relates to improvements in television systems.

In a television transmission system of one type, the picture signals are developed by apparatus in the form of a cathode ray tube comprising a mosaic photosensitive screen onto which an image of the object is projected, and an electron gun which develops a ray of electrons and directs the same at the screen. In operation, the ray is caused to scan the screen by electromagnetic coils or by plates. When coils are used, a saw-tooth current wave at a relatively high frequency is caused to pass through one set of coils to deflect the ray horizontally, and a saw-tooth current wave at a relatively low frequency is caused to pass through a second set of coils to deflect the ray vertically.

In these systems, it is required that synchronizing signals at the relatively high frequency and framing signals at the relatively low frequency be developed at the transmitter and transmitted with the picture signals for utilization at the receiving stations for the purpose of maintaining operating action thereat in synchronism and in frame with operating action at the transmitting station. When these impulses or signals are developed electrically, and transmitted in the same electrical channel, as in the system disclosed in my copending application bearing Serial No. 672,963, filed May 26, 1933, and assigned to Radio Corporation of America, occurrence of each framing signal is accompanied by the occurrence of several synchronizing signals. These signals add together in the common amplifier therefor to develop a given wave shape, which might vary from one frame to the next. If this action occurs, the possible effect is that the receiving apparatus falls out of frame.

Another possible disadvantage in the various systems proposed heretofore resides in the fact that the effectiveness of the horizontal synchronizing signals is interrupted during occurrence of the framing signals of greater duration. The result of this action is that during each frame the receiving apparatus is deprived of several synchronizing signals, and under certain conditions falls out of synchronism before the synchronizing signals again appear. With all the foregoing in mind, the object of my invention is to provide an improved television transmission system which avoids the difficulties and disadvantages referred to.

More particularly, an object of my invention is the provision of an improved television transmission system wherein synchronizing signals

and framing signals are transmitted in the same electrical channel under conditions which prevent the simultaneous occurrence of the synchronizing and framing signals in the common amplifier therefor, and, further, wherein the horizontal synchronizing signals are transmitted continuously for constant use at the receiver, without interruption by occurrence of framing signals, as heretofore.

Other objects and advantages will hereinafter appear.

In accordance with my invention, the synchronizing and framing signals are developed in separate circuits which supply a common electrical channel in which both kinds of signals appear and are amplified for transmission. In one embodiment of my invention, the framing signals are taken from the circuit developing the same and are applied to the other circuit and are utilized therein to prevent occurrence of the synchronizing signals simultaneously with the framing signals in the common amplifying channel. In another embodiment of my invention, the synchronizing signals are applied to the circuit for developing the framing signals and are utilized therein to suppress or interrupt each framing signal for a period of time somewhat greater than the period of duration of each synchronizing signal. This action, when represented graphically, results in the formation of gaps in the framing signals. The synchronizing signals, which would otherwise be lost during occurrence of the framing signals, then appear effectively in these gaps, so-called, so that there is no interruption in the transmission of the synchronizing signals. The suppression or interruption of the framing signals, in the manner and for the purpose explained, is not such as to render the framing signals ineffective for satisfactory framing action at the receiving apparatus.

My invention resides in the improved system, apparatus and method of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawings, wherein

Figure 1 is a diagrammatic view of a television transmission system embodying and operating in accordance with my invention;

Figs. 2, 2a, 3 and 3a are schematic views, illustrative of the operating action of the system shown in Fig. 1;

Fig. 4 is a view similar to Fig. 1, showing a modification; and

Figs. 5 and 6 are schematic views, illustrative

of the operating action of the system shown in Fig. 4.

The reference numeral 10 designates a cathode ray tube for developing picture signals. This tube comprises suitable photosensitive, mosaic screen structure 12, which, for example, may be made up of a great number of minute, photosensitized silver globules supported on a metallic base plate and each insulated from the latter and from each other. A suitable electron gun 14 operates to develop a ray 16 of electrons and to direct the same at the screen structure. The tube is provided with a grounded anode in the form of a silver coating 17 on the inside surface.

The ray 16 is caused to scan a rectangular area or "frame" of the screen structure forty-eight times a second. During relatively short periods between the frames, the ray is returned to the initial starting point for the next succeeding frame.

Let it be assumed, for example, that there are to be 48 pictures or frames a second. For these conditions, the ray is deflected horizontally by two coils 18 through which a saw-tooth current wave is caused to pass at a frequency of 5832 cycles. A suitable generator 20 supplies the current wave for this purpose. Also, the ray is deflected vertically by two coils 22 through which a saw-tooth current wave is caused to pass at a frequency of 48 cycles. A suitable generator 24 supplies the current wave for this purpose.

The electron gun 14 is provided with a control electrode or grid 26 by which the intensity of the ray is varied in the manner and for the purpose hereinafter explained.

An image of the object 28, which may be an outdoor view, a studio scene, or a moving-picture film, is projected onto the screen 12 by a suitable lens system 30.

Looking toward the right in the drawings, as the ray 16 scans the screen from left to right, individual electrostatic charges, previously stored on the globules constituting the surface of the screen are neutralized to develop picture signals in the output circuit of the tube 10. These signals are amplified in a suitable amplifier 40 and supplied by a connection 42 to a radio transmitter 44.

On account of the fact that the ray 16 is deflected horizontally 5832 times a second for 48 complete frames, there will be $121\frac{1}{2}$ lines for each complete frame. If 4 lines are taken up during the return deflection of the ray vertically, there will be $117\frac{1}{2}$ picture lines for each frame.

Under such conditions, for every 48 frames the ray 16 will be caused to scan the 24 odd frames along the same, spaced, parallel lines, and to scan the 24 even frames along the same parallel lines between the first-mentioned lines. This method of scanning is referred to as "interlaced" scanning, and is disclosed in detail in the copending application by Randall C. Ballard, bearing Serial No. 623,325, filed July 19, 1932, and assigned to the Radio Corporation of America. My invention is particularly useful in systems employing interlaced scanning, for the reason hereinafter explained.

For the purpose of maintaining operating action of the generators 20 and 24 at the respective frequencies, a suitable generator 46 is utilized to develop control signals which occur at the rate of 5832 a second, and other control signals which occur at the rate of 48 a second. The relative amplitude of these control signals and their occurrence with respect to the time

axis is indicated at 48 and 50, respectively, from which it will be noted that the control signals for vertical deflection are of much longer duration than the control signals for horizontal deflection, and that both of these signals are of the same amplitude. To avoid prolixity, the signals first referred to will, hereinafter, be designated as horizontal-control signals, and the second mentioned signals as vertical-control signals.

The generator 46 may, though not necessarily, be in the form of an apertured disc of the general type disclosed in the copending application by Arthur W. Vance, Serial No. 544,959, filed July 17, 1931, and assigned to Radio Corporation of America. The apertures in the disc (not shown) are such that the control signals have the same amplitude, the vertical-control signals, however, being of greater duration than the horizontal-control signals and occupying a time period equal to four horizontal return-line periods. After amplification in an amplifier 52, the control signals are impressed across resistors 54 and 56 and applied therefrom to the generators 20 and 24, respectively.

The construction and adjustments of the generator 24 are such that the same is responsive only to the vertical-control signals of substantially greater duration than the horizontal-control signals.

As indicated in the drawings, the tube 10 is supplied with the usual operating potentials.

Circuits A are utilized for the purpose of developing the synchronizing and framing signals for transmission. These circuits comprise an amplifier tube 58 having its grid circuit connected as shown to the plate circuit of an amplifier tube 60, and an amplifier tube 62 having its grid circuit connected to the plate circuit of an amplifier tube 64. The plates of the tubes 58 and 62 have a common resistor 66 for the purpose hereinafter explained. The voltage wave appearing across the horizontal deflecting coils 18 includes a saw-tooth component and an impulse component, and is applied by a connection 72 from these coils to the grid of the tube 60. The relative amplitudes and shapes of these components and their occurrence with respect to the time axis is indicated at 68 and 70, respectively. Hereinafter, the impulse components will be referred to as synchronizing signals.

The voltage wave appearing across the vertical deflecting coils 22 also comprises a saw-tooth component and an impulse component, and is applied by a connection 78 from these coils to the grid of the tube 64. The relative amplitudes and shapes of these impulses and their occurrence with respect to the time axis are indicated at 74 and 76, respectively. Hereinafter, the impulse components will be referred to as framing signals.

The synchronizing signals occur at the required frequency and are of the proper shape, amplitude and duration for synchronizing purposes. Also, the framing signals occur at the required frequency and are of the proper shape and amplitude for framing purposes. The synchronizing signals on the grid circuit of the tube 60 and the framing signals on the grid circuit of the tube 64 are of positive polarity for the reason that the return-line voltages across the coils 18 and 22 are of positive polarity. This is because the most efficient operation of the output tubes in the generators 20 and 24 which drive the coils 18 and 22, respectively, is obtained when the im-

pulses on their grids during these periods are of negative polarity.

The tubes 60 and 64 are biased negatively beyond plate-current cut-off, and the return-line scanning voltages are of the order of hundreds of volts, while the picture scanning voltages represented by the saw-tooth component are below 10% of the value of the return-line voltages. Also, the picture voltages are negative, while the return-line voltages are positive. For these reasons, the synchronizing and framing signals on the plates of the tubes 60 and 64, respectively, are in the form of negative impulses, as indicated at 80 and 82, and are of amplitude corresponding to plate saturation of the respective tubes. Also, the framing signals, occurring at the rate of 48 a second, are of greater duration than the synchronizing signals which occur at the rate of 5832 a second, by an amount corresponding to the difference between the duration of the horizontal control signals and the vertical control signals. Since both tubes 60 and 64 are biased beyond cut-off so that only the positive return-line voltages are effective to cause them to draw plate current, and to drive them to plate-current saturation, the signals in their plate circuits are flat-topped.

The tube 58 operates to amplify the synchronizing signals, which are of positive polarity in the plate circuit of this tube, as indicated at 84. The tube 62 operates to amplify the framing signals, which are of positive polarity in the plate circuit of this tube, as indicated at 86.

The synchronizing and framing signals are mixed in the resistor 66, and are supplied by a connection 88 to an amplifier circuit B.

The synchronizing and framing signals, as amplified in the circuit B, are then used for three distinct purposes, as follows: (a) by means of a connection 90, these signals are taken from a suitable stage of the circuit B, whereat the same are of sufficient amplitude and of negative polarity, as indicated by the Figure 92, and are applied to the grid 26 for the purpose of cutting off the ray 16 during the horizontal and vertical return-line periods; (b) by means of a connection 94, the synchronizing and framing signals are taken from a suitable stage of the circuit B, whereat the same are of sufficient amplitude and of negative polarity, as indicated by the Figure 96, and are applied to a selected stage of the amplifier 40 whereat these signals are effective to "block out" this amplifier during the horizontal and vertical return-line periods. In this manner, the amplifier 40 is prevented from passing and amplifying undesirable signals which might be developed during these return periods; and (c) by means of a connection 98, the synchronizing and framing signals are taken from a suitable stage of the circuit B, whereat they are of sufficient amplitude and of positive polarity, as indicated by the Figure 100, and are applied to a stage of the amplifier 40 which is beyond the stage at which the connection 94 is made, as indicated in the drawings, the action being to cause the synchronizing and framing signals to be amplified and transmitted with the picture signals from this point on. The amplitude of the synchronizing and framing signals in the connection 98 is such that they drive the tube supplied by this connection beyond the point of plate-current saturation. In this manner, and by making the connections 94 and 98 as explained, the synchronizing and framing signals transmitted with the picture signals are flat-topped and are

accompanied by practically no extraneous signals which otherwise might operate at the receiving stations to interfere with proper synchronizing action.

In operation, the amplitude of the framing signals is adjusted until they are substantially equal to the synchronizing signals. This is accomplished by adjusting the potentiometer 102 in the plate circuit of the tube 64. As stated, the synchronizing and framing signals are negative on the grids of the tubes 58 and 62 which are cut off by these signals. Any signals of positive polarity are blocked or prevented from passing by these tubes because no negative bias has been provided therefor, as represented in the drawings, and the grids of these tubes are prevented from swinging positive due to grid current in the high resistance shown connected in the grid circuits.

The width of the synchronizing signals is effected and can be varied by changing the value of a resistance 104 connected in series with the grid of the tube 58. An increase in the value of this resistance operates to increase the width or duration of these signals. The width of the framing signals can be increased by inserting a relatively small capacity 106 from the grid of the tube 62 to ground. The widths of the synchronizing and framing signals can also be changed by adjusting the bias voltages on the first impulse tubes 60 and 64.

While it is contemplated to supply the tubes 60 and 64 directly from the deflecting coils 18 and 22, or from the deflecting plates when these are used, it will be understood that the connections 72 and 78 can be made from other points in the respective generators 20 and 24 which provide the impulses having the proper amplitudes, durations and time occurrence for derivation of the synchronizing and framing signals. In such case, the connections 72 and 78 shown are omitted, and the connections made as indicated by the broken lines 72a and 78a.

In the system as just described, several of the synchronizing signals would appear simultaneously with each framing signal, as indicated in Figs. 2 and 3. On account of the fact that the framing frequency of 48 cycles is made to be an uneven multiple of the synchronizing frequency of 5832 cycles, in order to obtain the so-called interlaced scanning action referred to, the distribution of the synchronizing signals with respect to the framing signal for the odd frames, as represented in Fig. 2, is different than such distribution for the even frames, as represented in Fig. 3. The effect of this in the amplifier B is to produce a resultant framing signal of a somewhat different wave shape for the odd frames than for the even frames. These framing signals of different shapes have a varying control effect at the receiving apparatus which causes the same to drop out of frame unless all adjustments are exactly right. By my invention, however, occurrence of any synchronizing signals simultaneously with the framing signals is prevented, so that each framing signal has substantially the same shape. When represented graphically, the signals will appear as indicated in Fig. 2a which corresponds to Fig. 2, and as indicated in Fig. 3a which corresponds to Fig. 3. The manner in which this desirable action is obtained in my improved system will now be explained.

The framing signals in the output circuit of the tube 64, and which are of negative polarity, 75

as indicated at 82, are applied by a connection 103 to the grid circuit of an amplifier tube 110. These signals drive the tube 110 to saturation, so that the framing signals appear in the plate circuit as square-topped signals of positive polarity, as indicated at 112, and which, as shown, are applied to the grid circuit of a second amplifier tube 114. These signals drive the tube 114 to saturation, and appear in the plate circuit thereof as square-topped signals of negative polarity, as indicated at 116. By a connection 118, these negative signals are applied to a suppressor grid 120 with which the tube 58 is provided, and are of sufficient amplitude to drive the suppressor grid far enough negative so that this tube is cut off regardless of occurrence of the synchronizing signals on the grid 122. During the periods of occurrence of the framing signals, therefore, the tube 58 does not amplify or pass any synchronizing signals. The framing signals for both the odd and even frames then appear in the connection 88, amplifier B and connections 90, 94 and 98, as represented in Figs. 2a and 3a, without distortion by any synchronizing signals. The result is that each of the framing signals as received at the receiving stations has substantially the same shape, and each is therefore of equal effect and influence in keeping the receiving apparatus in frame.

With the purpose in mind of transmitting synchronizing signals continuously, even during the periods of occurrence of the framing signals, but without interference with the latter, I propose to embody my invention in a television transmission system as shown in Fig. 4, in which the parts and connections corresponding to those in Fig. 1 have been designated by the same respective reference characters as the latter.

The operating action in Fig. 4 is just the opposite of that in Fig. 1 in the sense that instead of the framing signals being utilized to cut out the synchronizing signals during the framing periods, as in Fig. 1, the synchronizing signals are utilized to cut out the framing signals for the periods during which the two kinds of signals would otherwise occur simultaneously.

In Fig. 4, an additional tube 124 is used to supply the grid circuit of the tube 110 with the synchronizing signals of negative polarity, as indicated at 126. The grid circuit of the tube 124 is supplied by a connection 128 with the voltage wave across the horizontal deflecting coils 18 and comprising the saw-tooth component and the impulse component, as indicated at 68 and 70, respectively. The bias on the tube 124 is such that it passes only the impulse components. The bias on the tube 110 is such that the synchronizing signals are effective to saturate this tube at a relatively low amplitude, so that these signals, appearing in the plate circuit and being then of positive polarity, are of somewhat greater duration than the synchronizing signals appearing in the connection 88. This is indicated at 130. The synchronizing signals of greater duration are applied to the grid circuit of the tube 114, and appear in the plate circuit thereof as negative signals, as indicated at 132. If required, the bias on the tube 114 may be made such that the synchronizing signals in the plate circuit thereof are of somewhat greater duration than these signals in the grid circuit of this tube.

By a connection 134, the negative synchronizing signals of greater duration are applied to a suppressor grid 136 with which the tube 62 is provided, and are of sufficient amplitude to drive

the suppressor grid far enough negative so that this tube is cut off regardless of occurrence of the framing signals on the grid 138. During the periods of occurrence of the synchronizing signals, therefore, the tube 62 does not amplify or pass the framing signals. By reason of this action, the framing signals for the odd frames will be interrupted, as represented in Fig. 5, to provide interruption periods for occurrence of the synchronizing signals indicated at 84. Similarly, the framing signals for the even frames will be interrupted, as represented in Fig. 6, to provide interruption periods for occurrence of the synchronizing signals indicated at 84. Since the interruption periods referred to are of greater duration than the synchronizing signals which occur during these periods, the receiving apparatus is enabled to distinguish these synchronizing signals which are then effective for their intended purpose. The interruption of the framing signals is not sufficient to interfere with their effectiveness at the receiving apparatus for framing purposes.

From the foregoing it will be seen that in my improved system as shown in Fig. 4, synchronizing signals are transmitted continuously, without interruption by the framing signals, and without interfering with the effectiveness of the framing signals at the receiving apparatus.

Considering the broadest aspect of the embodiment of my invention shown in Fig. 4, I believe myself to be the first to propose the method of operation in a television system wherein signals at a relatively low or framing frequency and synchronizing signals at a relatively high frequency are developed in separate electrical channels respectively, wherein there are developed, from the signals at the relatively low frequency, framing signals each of which is interrupted, and wherein the synchronizing signals and the interrupted framing signals are supplied to a common amplifier channel under conditions such that all signals are of the same polarity, and such that the periods of interruption of the framing signals are in phase with the periods of occurrence of the synchronizing signals.

It will be understood that the various values of resistance, capacity, voltage and frequencies have been given by way of example only, and that these can be varied over a substantial range to meet different requirements.

While but one embodiment of my invention has been shown and described, it will be understood that various changes within the conception of those skilled in the art can be made without departing from the spirit of my invention or the scope of the claims.

I claim as my invention:

1. In a television system wherein it is required that synchronizing signals and framing signals be transmitted in the same electrical channel, a circuit for developing the synchronizing signals, a circuit for developing the framing signals, an electrical channel supplied from said circuits and in which both the synchronizing and framing signals appear, and connecting means between said circuits for applying to one of said circuits the signals developed in the other circuit and under such conditions that the signals so applied are effective at the time to suppress operating action of said one of said circuits.

2. In the art of television, the method of operation which comprises scanning an object to develop picture signals, developing separately synchronizing and framing signals to control the

scanning action, and utilizing the signals of one kind to suppress the signals of the other kind.

3. In the art of television, the method of operation which comprises scanning an object to develop picture signals, developing separately synchronizing and framing signals to control the scanning action, and utilizing the framing signals to suppress the synchronizing signals.

4. In the art of television, the method of operation which comprises scanning an object to develop picture signals, developing separately synchronizing and framing signals, and utilizing the synchronizing signals to suppress at least part of the framing signals.

5. In the art of television wherein it is required that synchronizing and framing signals be developed for controlling the scanning action and transmitted in the same electrical channel and under conditions whereat there are periods of simultaneous occurrence of the framing signals and some of the synchronizing signals, the method of operation which comprises scanning an object to develop picture signals, developing separately synchronizing and framing signals to control the scanning action, supplying both kinds of signals to a common electrical channel, and utilizing the synchronizing signals to suppress the framing signals only during such simultaneous periods of occurrence whereby any control action during these periods is only that due to the synchronizing signals.

6. In a television system wherein it is required that synchronizing signals and framing signals be transmitted in the same electrical channel, a circuit for developing one kind of signals and including an electron tube, a circuit for developing the other kind of signals and including an electron tube provided with a grid, an electrical channel supplied from said circuits and in which both the synchronizing and framing signals appear, and connecting means between the output circuit of said first-named tube and said grid for applying to the latter the signals in said output circuit and under such conditions of polarity that each of the signals so applied is effective to cut off said second-named tube.

7. In a television system wherein it is required that synchronizing signals and framing signals be transmitted in the same electrical channel, a circuit for developing synchronizing signals, a circuit for developing the framing signals and including an electron tube provided with a grid, an electrical channel supplied from said circuits and in which both the synchronizing and framing signals appear, and means for applying to said grid signals occurring in time with the synchronizing signals and each being greater in duration than the latter and each being of such polarity when applied to said grid to cut off said second-named tube.

8. In a television system wherein it is required that synchronizing signals and framing signals be transmitted in the same electrical channel, a circuit for developing the synchronizing signals and including an electron tube provided with a grid, a circuit for developing the framing signals and including an electron tube, an electrical channel supplied from said circuits and in which both the synchronizing and framing signals appear, and means for applying to said grid the signals in the output circuit of said second-named tube and under such conditions of polarity that

each of the signals so applied is effective to cut off said first-named tube.

9. In a television transmitter, means for generating comparatively narrow electrical synchronizing impulses which occur at a comparatively high frequency, means for generating comparatively wide unslotted electrical framing impulses which occur at a comparatively low frequency, means for producing slots in each of said wide impulses of such width and so located that said narrow impulses may be inserted therein, and means for adding said narrow impulses and said slotted impulses.

10. In a television transmitter, means for generating substantially rectangular narrow electrical impulses which occur at a comparatively high frequency, means for generating substantially rectangular wide electrical impulses which occur at a comparatively low frequency, means for producing gaps or slots in said wide impulses which are of such width and which occur in such time relation that said narrow impulses may be inserted therein, and means for adding said narrow impulses and said slotted wide impulses.

11. In a television transmitter for transmitting a composite signal comprising picture signals, comparatively high frequency synchronizing impulses and comparatively low frequency framing impulses, means for producing said synchronizing impulses, means for producing said framing impulses, a plurality of amplifier channels, said first means being connected to one of said channels, said second means being connected to another of said channels, means for adding the outputs of said channels, and means for rendering one of said channels ineffective to transfer a signal during the occurrence of one of said impulses which is being supplied to another of said channels.

12. In a television transmitter, means for generating substantially rectangular narrow electrical impulses which occur at a comparatively high frequency, means for generating substantially rectangular wide electrical impulses which occur at a comparatively low frequency, an amplifier channel connected to said first means, a second amplifier channel connected to said second means, means for rendering said second channel ineffective to pass a signal for approximately only the period that said narrow impulses and said wide impulses occur simultaneously, and means for adding the outputs of said amplifier channels.

13. In a television transmitter, means for generating substantially rectangular electrical framing impulses, an amplifier channel connected to said means, and means for blocking said channel a plurality of times during the occurrence of one of said framing impulses.

14. The method of producing a composite synchronizing signal in a television system which includes the steps of producing comparatively narrow electrical impulses which occur at a comparatively high frequency, producing comparatively wide unslotted electrical impulses which occur at a comparatively low frequency, producing slots in each of said wide impulses of such width and so located that said narrow impulses may be positioned therein, adding said narrow impulses and said slotted impulses to produce said composite signal.

RICHARD L. CAMPBELL.