

Aug. 20, 1940.

C. O. BROWNE ET AL

2,212,199

TELEVISION AND THE LIKE TRANSMITTING SYSTEM

Filed Nov. 19, 1935

4 Sheets-Sheet 1

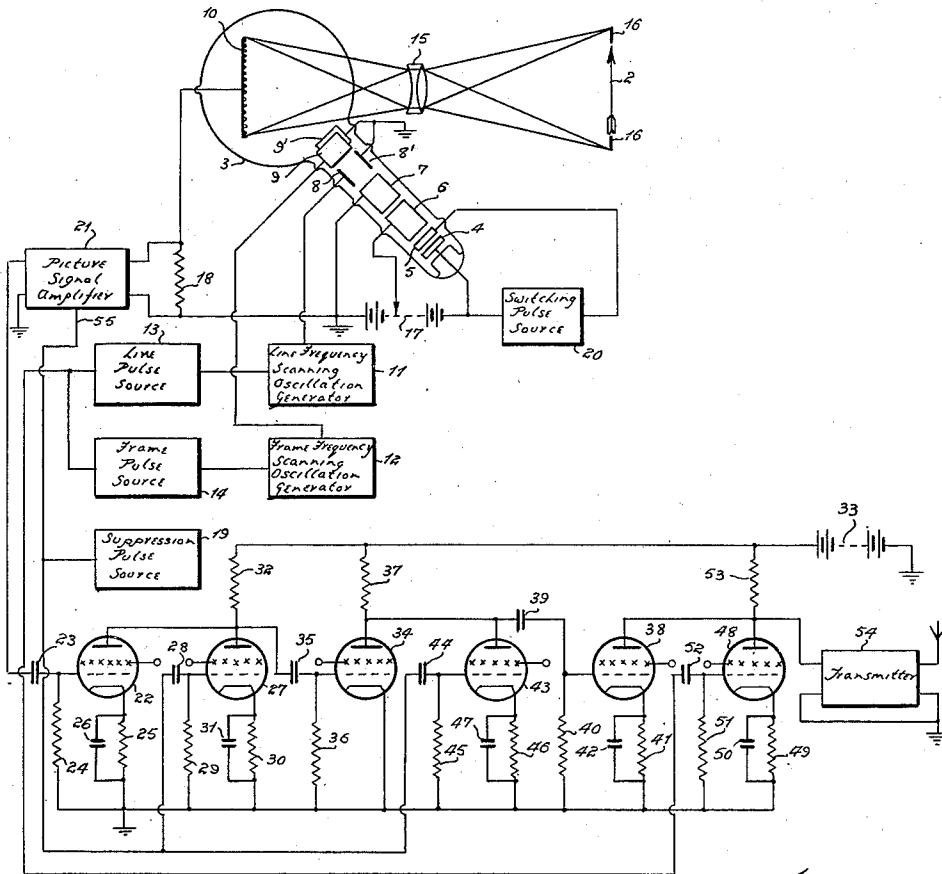


Fig. 1.

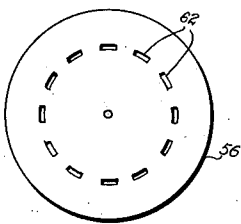


Fig. 11.

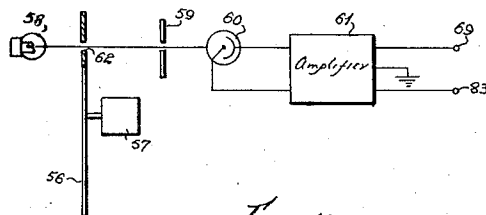


Fig. 10.

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4 Sheets-Sheet 2

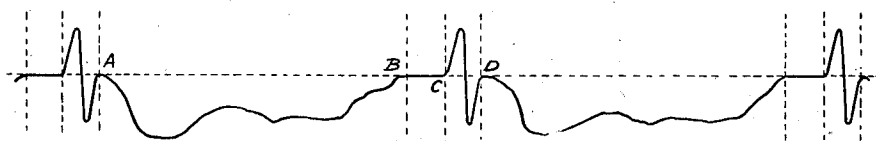


Fig. 2.

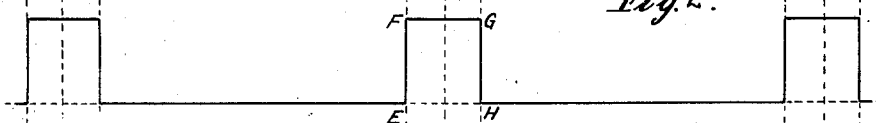


Fig. 3.

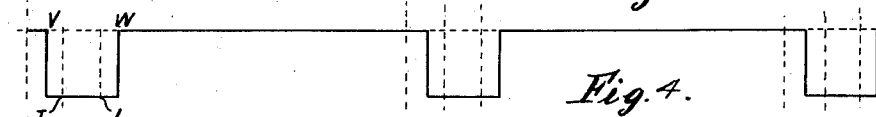


Fig. 4.

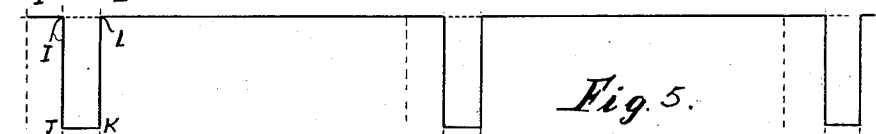


Fig. 5.

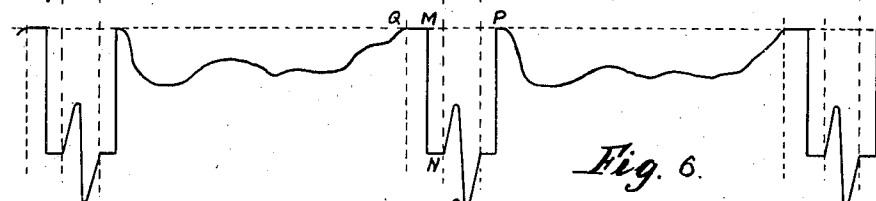


Fig. 6.

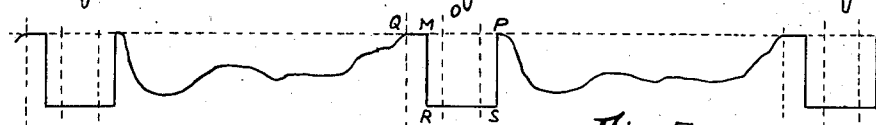


Fig. 7.

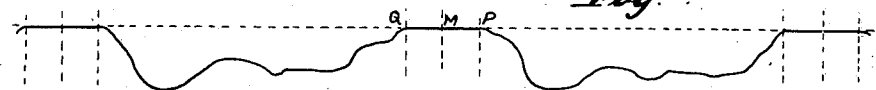


Fig. 8.

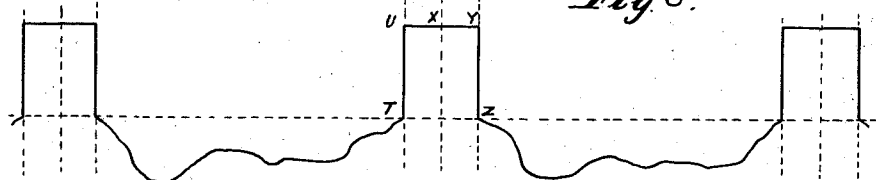


Fig. 9.

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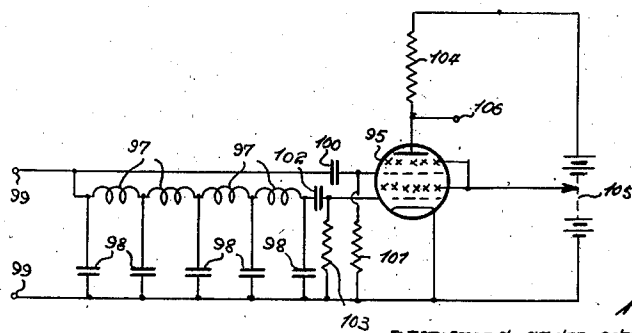
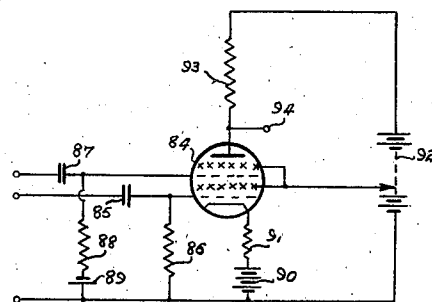
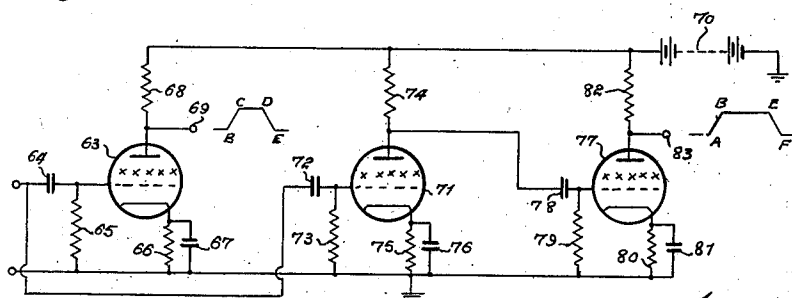
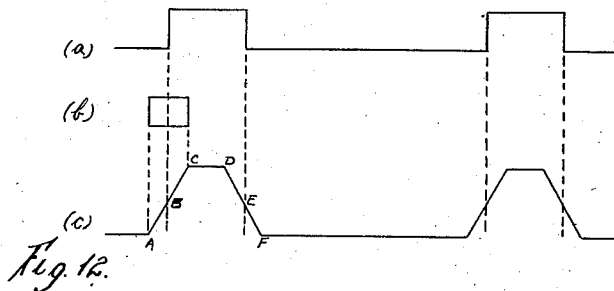
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4 Sheets-Sheet 3



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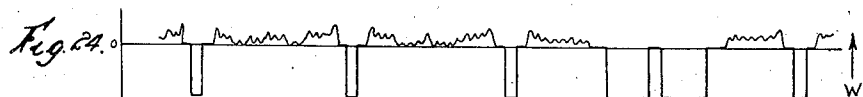
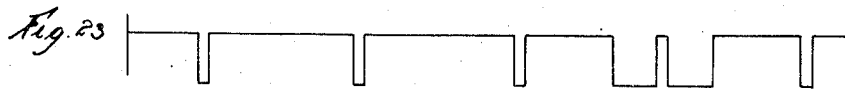
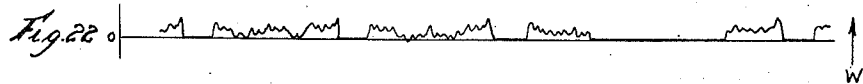
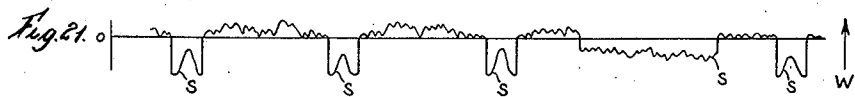
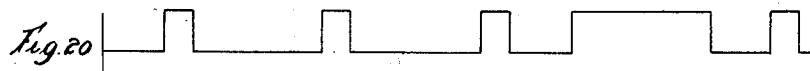
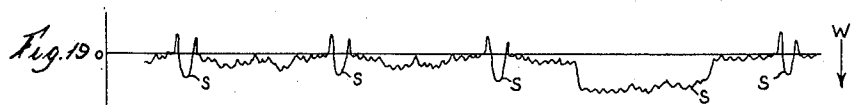
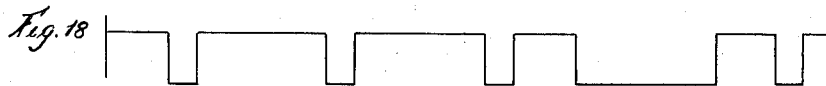
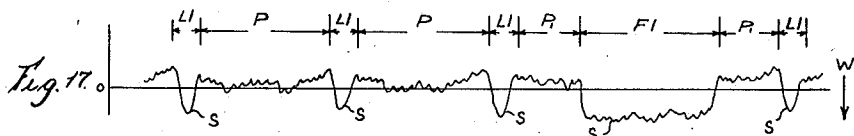
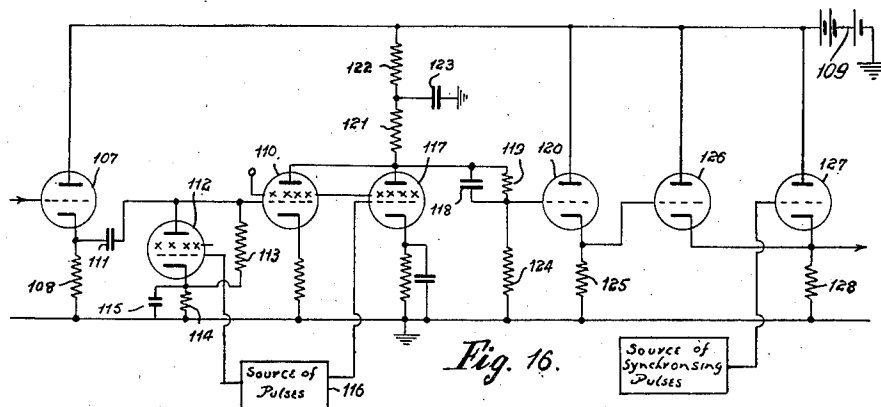
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TELEVISION AND THE LIKE TRANSMITTING SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,212,199

TELEVISION AND THE LIKE TRANSMITTING SYSTEM

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Application November 19, 1935, Serial No. 50,560
In Great Britain November 19, 1934

10 Claims. (Cl. 178—7.1)

The present invention relates to television and the like transmitting systems.

In most known television systems an object to be transmitted is scanned in contiguous strips and electrical variations are derived from the changes in brightness of the elemental areas of the object. When the object has been completely scanned, the operation is repeated. This complete scanning may take place 24 times per second for example. Since the absolute level of brightness has significance to the eye it is necessary to reproduce in the final picture all changes in brightness of the object, however slowly these changes may occur, if the final result is to be an undistorted representation of the object. It will be evident that in order to convey always the correct impression of absolute brightness it is necessary to transmit and receive frequencies down to and including zero frequency. Usually, however, the amplifiers serving to amplify the signals prior to transmission have a low frequency cut-off, for example they may be capable of amplifying from about 10 cycles per second to 400,000 or more cycles per second, and below 10 cycles per second the amplification falls rapidly.

Moreover some picture signal generators, for example certain cathode ray tube transmitters, do not develop the direct current and very low frequency components of the picture signals.

In order to insert accurately the direct and low frequency components, hereinafter referred to for shortness as the D. C. component, it is found to be essential that the amplitude of the picture, or combined picture and synchronising signals should attain a fixed maximum or minimum value, relative to the value corresponding to black in the picture, at suitable intervals of time, the device which reinserts the lost frequencies operating with reference to this recurrent fixed signal amplitude.

Where scanning is effected with the aid of a cathode ray tube, the ray is deflected over a screen by means of two suitable scanning fields, which vary at different frequencies. By each field the ray is deflected across the screen in what will be called a "scanning stroke," the scanning field being then reversed in sense and the ray being deflected back across the screen at a comparatively high speed in what will be called a "return stroke." The higher frequency field may be called the line scanning field and the lower frequency field the frame scanning field. The ray is preferably extinguished during the return strokes to avoid the generation of picture signals at these times.

It has been found, however, that spurious unwanted signals arise in the picture signals during the return strokes of both fields and during the scanning strokes at the beginning or end of a line or frame just following the turning on or off of the cathode ray. Thus, for example, unwanted signals may occur at the beginning or end of a line scanning stroke or at any time during a line return stroke. The amplitude of the unwanted signals depends upon the intensity of the scanning ray and also, in a somewhat obscure manner, upon the nature of the object being transmitted. Unwanted signals of a similar nature are also developed under some conditions at the beginnings or ends of the frame scanning strokes or at any time during the frame return strokes. The cutting off of the cathode ray during return strokes reduces the magnitude of the disturbing signals but itself introduces other disturbances.

The unwanted signals may consist of excursions in both the black and white directions and their presence may make it difficult or impossible to reinsert direct current and low frequency components into the picture signals in the manner referred to above.

It has already been proposed to remove spurious signals, such as those above described, by superimposing upon the picture signal intervals in which the spurious signals occur pulses which drive the signal amplitude beyond the peak level of the picture signals and by then limiting the signal amplitude.

It is an object of the present invention, therefore, to provide an improved method and means for partially or wholly removing the spurious signals produced by the cutting off and turning on of the cathode ray or occurring from any cause between the scanning of successive lines or frames of a picture, or for preventing such spurious signals from affecting the insertion of the D. C. component.

According to the present invention, there is provided a method of television transmission in which spurious signals occur in the intervals between groups of picture signals and in which the spurious signals are removed, wherein the D. C. component of said picture signals is arranged to be present at the point at which the spurious signals are removed, the spurious signals being replaced by a signal having an amplitude corresponding to or at least fixedly related to picture black.

The D. C. component of the picture signals is present at the point at which the spurious signals are removed when, at that point, all parts of the

picture signals which correspond to black in the object are represented by the same potential.

According to a feature of the present invention there is provided a method of television transmission in which scanning is effected with the aid of a cathode ray tube, the cathode ray being periodically deflected, by means of a suitable electrostatic or electromagnetic scanning field, from one edge of the area scanned to the opposite edge thereof, the scanning field being then reversed in sense and the ray being deflected, in a return stroke to the first-named edge at a comparatively high speed, the picture signals so generated being passed to a suitable amplifier, wherein, during the return strokes of the cathode ray, the output of the amplifier is substantially isolated from the input thereof, the D. C. component being arranged to be present at the point where isolation is effected. Thus the amplification of the amplifier may be reduced substantially to zero during the return strokes, for example by the application thereto of suitable pulses which bias one or more control grids thereof to anode current cut-off. The cathode ray is also preferably cut off and in this case the cutting-off and turning-on of the ray is advantageously effected at such times that, allowing for any delay which the picture signals may undergo before reaching the point at which isolation is effected, any spurious signals which may arise due to the cutting-off or turning-on of the ray arrive at the isolating point after the amplification has been reduced, and before the amplification is restored to its normal level.

According to a further feature of the present invention there is provided a method of television transmission in which spurious signals occur in the interval between groups of picture signals and in which there are superimposed upon the picture signals during said intervals suppression pulses of such sense and magnitude as to displace the spurious signals beyond the level of picture signals, the spurious signals being then removed by limiting the amplitude of the picture signals, wherein it is arranged that the D. C. component of said picture signals is present at the point at which said superimposition takes place. To enable the D. C. component to be reinserted if it has been lost, the picture signals may be caused, during a part of each line scanned, to assume a value corresponding to black, these recurrent values being utilised for reinsertion purposes. The whole of the signal in the interval between successive lines is preferably, after the elimination of the unwanted signals, caused to assume a value corresponding to black, for example by superimposing impulses of suitable nature upon the signals, and synchronising signals may then be superimposed upon these "black" interval signals.

The present invention also provides a method of television transmission in which the D. C. component is inserted with reference to a recurrent fixed amplitude value of the signal and in which there occur in intervals between groups of picture signals spurious signals which may interfere with the insertion of the D. C. component, wherein the device by which the insertion is effected is rendered unresponsive to signals of said amplitude value during said intervals.

The invention will now be described, by way of example, with the aid of the accompanying diagrammatic drawings, in which Fig. 1 is a schematic drawing of a television transmitter,

Fig. 2 shows the wave form of picture signals

developed by the cathode ray tube 3 in the apparatus of Fig. 1 and containing the unwanted signals referred to above,

Fig. 3 shows the wave form of synchronising signals before they are mixed with the picture signals,

Fig. 4 shows the wave form of the signals used for cutting off the amplifier and eliminating the unwanted signals,

Fig. 5 shows the wave form of the signals which are used in cutting off the cathode ray,

Fig. 6 shows the wave form of the picture signals combined with the suppression signals of Fig. 4, after suitable amplification of the latter,

Fig. 7 shows the wave form of the combined picture and suppression signals after elimination of the unwanted signals,

Fig. 8 shows the interval signals reduced to "black" level and

Fig. 9 shows the wave form of the signals of Fig. 8 combined with the synchronising signals of Fig. 2,

Fig. 10 shows apparatus for generating suppression and neutralising pulses,

Figs. 11 and 13 show details of the apparatus of Fig. 10,

Fig. 12 is an explanatory diagram,

Fig. 14 shows modified apparatus according to the invention,

Fig. 15 illustrates a method of generating neutralising pulses,

Fig. 16 is a circuit diagram of apparatus for carrying out the present invention, and

Figs. 17 to 24 are explanatory drawings illustrating the wave forms of signals at various points in the apparatus of Fig. 16.

In all the figures containing graphs, with the exception of Fig. 12a, ordinates represent current or voltage and abscissae represent time.

Referring to Fig. 1, picture signals corresponding to an object 2 to be transmitted are generated by means of a cathode ray tube 3, having a cathode 4, a modulator electrode 5, two anodes 6 and 7, two pairs of deflecting plates 8, 8' and 9, 9' and a screen 10 comprising a mosaic of photo-electric elements disposed upon a signal plate. The anodes 6 and 7 are held at positive potentials relative to the cathode 4 by means of a source of current indicated at 17, the positive terminal of which is earthed. The mosaic screen is connected to earth through a signal resistance 18.

The deflecting plates 8' and 9' are connected to earth: plate 8 is connected to a line-frequency scanning oscillation generator 11, while plate 9 is connected to a frame-frequency scanning oscillation generator 12. Generators 11 and 12 are fed with synchronising pulses from sources 13 and 14, the impulses from which occur at the line and frame frequencies respectively. The form of the impulses generated by source 13 is shown in Fig. 3; source 14 generates similar rectangular impulses. The line and frame frequencies are so chosen that the cathode ray scans the mosaic screen 10 in a series of substantially straight parallel lines, each scanning stroke being followed by a relatively rapid return stroke.

An optical system indicated generically at 15 is provided to project an image of the object 2 upon the mosaic screen 10.

The object 2 is provided with a black border indicated at 16, so that the cathode ray, after scanning a line of the object 2, scans a black zone corresponding to the border 16; the border may be provided in any known or suitable man-

ner. Means which are further described below, are provided for cutting off the cathode ray during the return strokes, and for turning it on again at the beginnings of the scanning strokes.

5 A portion of the signal generated by the apparatus described and appearing across resistance 18, is illustrated in Fig. 2, in which the signal between A and C represents the signals generated in scanning one line, while the part CD
10 corresponds to a return stroke; AB represents picture signals, BC represents the part of the signal due to the black border 16, and CD represents the spurious signals which are generated, during the return stroke, while the ray is cut off.

15 The portion BC due to the black border constitutes a recurrent signal of fixed amplitude value which is suitable for use in the re-insertion of the D. C. component of the picture signals. A method by which this reinsertion may be accomplished will be described later with refer-
20 ence to Fig. 1, and it will be sufficient to indicate here that the method involves the application of the signal of Fig. 2, the D. C. component of which it is assumed that it is desired to re-insert, to a circuit comprising a unidirectionally conducting device, and a condenser provided with a leak
25 resistance, it being arranged that current just flows to the condenser through the unidirectionally conducting device when the part BC of the signal is present, the picture signals AB producing no flow of current.

It will be evident that the spurious signals indicated at CD in Fig. 2 will interfere with the re-
35 insertion of the D. C. component by the method outlined, since the excursions of the signal of Fig. 2 in the upward direction from the straight line ABCD will cause current to flow in the unidirectionally conducting device.

It will be understood that the recurrent fixed
40 amplitude value which serves for reinsertion of the D. C. component need not correspond to black so long as it is fixedly related to black, and so long as suitable steps are taken to make a pre-determined fixed current or voltage correspond with black in the signal.

45 It is desired firstly to eliminate the unwanted signals CD, and secondly to insert signals suitable for synchronising purposes.

Normally, synchronising pulses derived from
50 the synchronising pulse sources (13 and 14, Fig. 1) at the transmitter are mixed with the picture signals in such manner that one line synchronising pulse occupies between one half and the whole of the interval between two successive line
55 trains of picture signals, and in order that the synchronising pulses may be easily separated from the trains of picture signals at the receiver the synchronising pulses are inserted into the transmission channel in the "blacker-than-black" direction, that is, in the opposite direction from a datum line corresponding to black to that corresponding to an increase in brightness of the object.

It is desirable, therefore, that the signals BCD
65 of Fig. 2 should be converted into signals of the shape TUXYZ shown in Fig. 9 and this may be done in the following manner:

70 Suppression pulses of the kind shown at VILW in Fig. 4 are generated, by means of a source 19, in fixed phase relationship to the line synchronising impulses shown at EFGH in Fig. 3; it will be noted that the line synchronising signals last for a time substantially equal to that occupied by the part BCD of Fig. 2, while the suppression
75 pulses are arranged to last for a time rather

greater than that occupied by part CD of Fig. 1, that is, the spurious signals.

A set of pulses of the form shown in Fig. 5 is also generated, by means of source 20, in fixed
5 phase relationship to the line synchronising signals; the pulses of Fig. 5 which last for a time at least equal to that during which the spurious signals may be developed, will be referred to as switching pulses, and are applied between the
10 modulator 5 and the cathode 4 of the tube 3 in such a sense, and at such an amplitude level, that they serve to reduce the intensity of the cathode ray substantially to zero, or, in other words, to cut off the ray.

The signals set up across resistance 18, which
15 have the form shown in Fig. 2, are fed through picture signal amplifier 21, which will be assumed to be an amplifier which is incapable of amplifying the D. C. component of the picture signal to the control grid circuit of a tetrode
20 valve 22, which has a grid condenser 23 and grid leak 24 in its grid circuit, and a biasing resistance 25 shunted by a by-pass condenser 26 in its cathode circuit. Suppression pulses from source 19 are fed to the grid circuit of a tetrode
25 valve 27 having a grid condenser 28, grid leak 29, biasing resistance 30 and by-pass condenser 31. The anodes of valves 22 and 27 are connected through a common anode resistance 32 to the positive terminal of a source 33 of anode current, the negative terminal of which is earthed;
30 the screening grids of these valves are also connected to a suitable point in source 33 by connections which, for the sake of simplicity, have been omitted from the drawings.

The picture signals, Fig. 2, are applied to valve
35 22 in such sense that an increase in picture brightness corresponds to a decrease in the negative potential of the control grid of that valve, while the pulses of Fig. 4 are similarly arranged to drive the control grid of valve 27 less negative.
40 The signals of Figs. 2 and 4 are in this way mixed together, the form of the mixed signal, which is set up across resistance 32, being as indicated in Fig. 6, except that the D. C. component of the picture signals is missing, having been
45 lost in amplifier 21 and in the coupling to valve 22. The amplitude of the suppression pulses is made such that the combined amplitude (MNOP, Fig. 6) of suppression pulses and spurious signals is always brighter than black, and preferably
50 greater than the maximum amplitude occurring in the picture signals.

As has already been pointed out, the signals set up across resistance 32 lack the D. C. com-
55 ponent. This component is now reinserted by means of tetrode valve 34, which has a grid condenser 35 and a grid leak 36 in its control grid circuit.

The signals applied to valve 34 consist of variations about a datum line such that the areas enclosed by the signal envelope above and below the datum line are equal, and it is arranged that signal excursions in the downward direction of
60 Fig. 6 cause the control grid of valve 34 to become more negative. The applied signal causes grid current to flow in valve 34, and condenser 35 charges up, the control grid potential thus becoming more negative. A state is eventually
65 reached in which only the parts QMP (Fig. 6) of the signal will cause grid current to flow, the time constant of condenser 35 and leak 36 being made such that only a slight change in control grid potential takes place between successive parts QMP. The datum line is thus changed to
75

one through the peak portions QMP of the signal, and the D. C. component is thus restored.

The grid base of valve 34, that is, the change in potential required to swing the control grid of valve 34 from zero potential (relatively to the cathode) to the potential corresponding to anode current cut-off, is made such that the signal of Fig. 6 is converted in valve 34 into a signal of the form shown in Fig. 7; in other words, it is arranged that parts of the signal of Fig. 6 beyond a line corresponding to the line RS of Fig. 7, lie in the region of control grid potentials more negative than that corresponding to anode current cut-off, and are thus removed. The valve 34 thus serves not only to re-insert the D. C. component, but also as an amplitude limiting device.

The anode of valve 34 is connected to the positive terminal of source 33 through anode resistance 37, and the signals set up across this resistance, which have the form indicated in Fig. 7, are fed to the control grid circuit of a further valve 38, which has a grid condenser 39, a grid leak 40, a biasing resistance 41 and by-pass condenser 42. Suppression pulses from source 19 are applied to the control grid of a valve 43 having a grid condenser 44, grid leak 45, biasing resistance 46 and by-pass condenser 47, in such a sense as to drive the control grid of valve 43 in the positive sense. The valves 43 and 34 both have the same anode resistance 37, and the outputs of valves 43 and 34 are mixed together across this resistance, it being arranged that the pulses fed to valve 43 are substantially equal in amplitude and opposite in sense to the parts MRSP of the signal of Fig. 7. The signal fed to valve 38 thus has the form shown in Fig. 8, the parts MRSP of the signal of Fig. 7 being replaced by intervals of black, or substantially black level. The pulses of Fig. 4 serve in the valve 43 as neutralising pulses.

The signal of Fig. 8, which is free from spurious signals, is now mixed with synchronising pulses; the latter are derived from generators 13 and 14, and are applied to a valve 48 having a biasing resistance 49, by-pass condenser 50, grid leak 51 and grid condenser 52. Valves 38 and 48 have a common anode resistance 53; the synchronising pulses are fed to valve 48 in such sense that they are mixed with the picture signals in the blacker-than-black sense, the mixed signals set up across resistance 53 being of the form illustrated in Fig. 9. The mixed signals are then fed to a radio transmitter indicated at 54.

In the arrangement described, the re-insertion of the D. C. component is effected at the point where the superimposition of the suppression pulses takes place. If desired, the D. C. component may be re-inserted after the point at which the suppression pulses are superimposed on the picture signals, and for this purpose, the valve 22 and 27 of Fig. 1 may be omitted, the picture signals and suppression pulses previously mixed being fed directly, in suitable sense, to the control grid circuit of valve 34. It is not necessary that amplitude limitation should be effected by the re-inserting valve, and the functions of valve 34 of Fig. 1 may be performed by two D. C. coupled valves, the first effecting re-insertion, and the second, amplitude limitation.

It will be seen that in order to obtain the signal of Fig. 8, in which groups of picture signals are separated by black, or substantially black intervals, independently of changes in average picture brightness, it is important that the D. C. component should be present in the signals fed to

the limiting valve 34, as above described, and if this component is not re-inserted simultaneously with the super-imposition of the suppressing pulses of Fig. 4, it must be re-inserted before limitation is effected. When the D. C. component is present at the limiting valve, the part MRSP of the signal of Fig. 7 is the same in every interval, and a neutralising pulse of constant amplitude can thus be employed.

The pulses of Fig. 4 can be used not only as suppression and neutralising pulses, but also to reduce the amplification of one or more of the valves of the picture signal amplifier 21, preferably substantially to zero, in this way isolating the output of the amplifier from the input thereof. For this purpose, the pulses of Fig. 4 may be fed over lead 55 from source 19 to amplifier 21, and applied to bias the grids of the amplifier valves to or beyond anode current cut-off. Preferably at least the valve nearest the source of picture signals is cut off in this way and other later valves may also be cut off if desired.

It will be noted that owing to the shapes of the pulses of Figs. 4 and 5, the amplifier 21 is cut off at V (Fig. 4) before the cathode ray is cut off at I (Fig. 5) and the ray is again turned on at L (Fig. 5) before the amplifier is turned on at W (Fig. 4). In determining the shapes of the pulses of Figs. 4 and 5, due regard must be had to any delays which the picture signals may undergo up to the point where the amplifier 21 is cut off, so that the spurious signals always arrive at that point after the amplifier is cut off and cease before it is turned on again. Spurious signals arising from the cutting off and turning on of the cathode ray are in this way at least substantially suppressed.

Instead of producing a black signal BC (Fig. 2) at the end of each line, a "whiter-than-white" signal may be produced. By a whiter-than-white signal is meant a signal value in the white direction from black and further removed from black than full white in the image of the object. Such a signal may be produced for example by forming an image of an elongated source of light upon one side of the image upon the mosaic screen, and for this purpose, the black border 16 of Fig. 1 is arranged to be replaced by this bright image. The brightness of the marginal image is made such that it will always be greater than that of the brightest part of the image of the object 2 formed upon the screen 16. The D. C. component of the picture signals is re-inserted with reference to the recurrent whiter-than-white signal value instead of black value QM in Fig. 6.

Suppression pulses from source 19 are arranged, as before, to drive the unwanted signals so far in the white direction that they can be removed by an amplitude limitation, in a manner such as has already been described. The resultant interval signal, which then has a whiter-than-white value, is brought to the condition TUXYZ, shown in Fig. 9, by superimposing upon the picture signals synchronising pulses of the form shown in Fig. 2, these pulses being derived from sources 13 and 14 and being superimposed upon the picture signals in such a sense, and at such an amplitude level that signals of the form of Fig. 9 are obtained. In this way, the whiter-than-white pulses are removed from the signals as well as the spurious signals. If it is found that the spurious signals extend beyond the whiter-than-white signals in such a way that they

would interfere with the re-insertion of the D. C. component, pulses of the kind shown in Fig. 4 may be superimposed upon the signals at the re-insertion point, these signals being derived from source 19 and being arranged to be in such sense as to drive the spurious signals to a sufficient extent in the black direction. The procedure thereafter may be as before.

The pulses of Figs. 4 and 5 may be generated by means of a disc having two series of apertures of suitable shape arranged on concentric circles, the disc rotating between a pair of light sources and two co-operating photo-sensitive cells. Apparatus of this kind will be described later with reference to Figs. 10 and 11. The synchronising signals of Fig. 2 may be generated by a second series of apertures in the same disc, arranged to co-operate with a separate cell.

In a further arrangement, the D. C. component is not re-inserted with reference to a black or whiter-than-white signal arranged to occur at the end of each line, in the manner described above, but is re-inserted with reference to peaks of the picture signal in the black direction. The black border or bright image 16 referred to above may then be omitted, and it should be noted that in this further arrangement, the durations of the pulses of Figs. 2, 4 and 5 must be chosen with the fact in mind that the interval BC of Fig. 2 is no longer present.

It has been found difficult to ensure that the pulses employed as neutralising pulses have exactly the same duration and shape as the suppression pulses. If they have a different duration, narrow, peaky pulses in one sense or the other will remain after the superimposition of the neutralising pulses. If these residual pulses are in the white direction, they may cause white lines to appear at the edge of the final picture. If the residual pulses are in the blacker-than-black direction they are likely to disturb the synchronisation, since the synchronising signals are usually in this direction in the transmitted signal.

It may therefore be arranged that the durations of the suppression and neutralising pulses are different and such that the residual pulses are in the blacker-than-black direction. The residual pulses are then removed by means of a suitable limiting device before the admixture of the synchronising pulses. Usually the suppression pulses are applied in the white direction and they are then made of shorter duration than the neutralising pulses.

One method of generating suppression and neutralising pulses of different duration will now be described with reference to Figs. 10 to 13 of the accompanying drawings. Referring to Fig. 10, a disc 56 is driven, by means of a motor 57, to rotate between a light source 58 and an apertured diaphragm 59, behind which is a photo-electric cell 60. The pulses set up in the cell 60 are fed to an apparatus 61, which comprises an amplifier and means, which will be described with reference to Fig. 13, for dividing these pulses into two separate sets. Fig. 11 is a front elevation of the disc 56, which has a plurality of substantially rectangular apertures 62 formed therein.

Referring to Fig. 12, the graph *a* represents the intensity of the light falling on the diaphragm 59 plotted against time as abscissae, while *b* represents the form of the aperture in the diaphragm 59. The curve *c* represents the form of the pulses set up in cell 60, amplitude of pulse being plotted against time as abscissae. Each

aperture 62 in disc 56 gives rise to a tapered pulse ABCDEF of the form shown in Fig. 12c, and these pulses, after amplification in amplifier 61, are fed to the control grid circuit of a valve 63 through a grid condenser 64 with which is associated leak resistance 65.

The valve 63 is biased by means of biasing resistance 66 and condenser 67 to a point which is more negative than that corresponding to anode current cut-off, and the pulses of Fig. 12c are arranged to drive the control grid of valve 63 less negative. The value of the grid bias is so chosen that only the upper portions BCDE of the pulses cause anode current to flow; the anode of valve 63 is connected through resistance 68 to the positive terminal of a source 70 of anode current, and pulses of the form BCDE appear at terminal 69, and are employed as suppression pulses.

The pulses of Fig. 12c are also applied to a valve 71, having a grid condenser 72, leak 73 and anode resistance 74, which is so biased by means of resistance 75 and condenser 76 that it effects no amplitude limitation of the pulses, but reverses them in sense and applies them to valve 77 by means of condenser 78 and leak resistance 79. Valve 77 is so biased by means of resistance 80 and condenser 81 that anode current only flows therein for the parts AB EF of the pulses of Fig. 12c. The anode of valve 77 is connected to the positive terminal of source 70 through resistance 82, and pulses of the form AB EF appear at the terminal 83, whence they are led away to serve as neutralising pulses.

The neutralising pulses, which are constituted by the lower portions of the tapering pulses of Fig. 12c, are thus arranged to be of longer duration than the suppression pulses, which are constituted by the upper portions. The suppression pulses are conveniently mixed with the picture signals in the white sense, so that when, after the reinsertion of the D. C. component, and subsequent limiting, the neutralising pulses are superimposed, the residual impulses are in the blacker-than-black sense, and can be removed by an amplitude limitation by a method such as has already been fully described.

Instead of generating the suppression and neutralising pulses as above described from a single set of tapering pulses, the two sets of pulses may be generated separately. For example, two sets of pulses may be generated optically in a manner such as that described with reference to Figs. 10 and 11, with the aid of two sets of apertures of different widths. Alternatively, the pulses may be derived from two separate electrical pulse generators.

It is however, advantageous to use what is effectively a single set of pulses, namely the two parts of the tapering pulses, for both suppression and neutralising, because a change in the tapering pulse, for example in its length, affects both suppression and neutralisation equally.

A modified circuit arrangement, applicable whether the suppression and neutralising pulses are of equal or unequal durations will now be described with reference to Fig. 14. Referring to Fig. 14, the signals of the form of Fig. 6, containing their D. C. component, are applied to the inner control grid of a hexode valve 84 through grid condenser 85 and leak 86, the neutralising pulses being applied to the outer control grid through grid condenser 87, with which is associated leak 88 and a source 89 of biasing potential. The inner grid is biased by means of source 75

90. The picture signals are applied in such sense that they render the inner grid less negative, whilst the neutralising pulses applied to the outer grid render it more negative. A resistance 91 providing negative reaction is arranged in the cathode lead of the valve 84 to straighten the characteristic and sharpen the bottom bend. The anode of valve 84 is connected to the positive terminal of a source 92 of anode current through a resistance 93, and the screening grids are connected to a point at a positive potential in source 92. It is arranged that, with the outer control grid at the potential it assumes in the intervals between neutralising pulses, picture black corresponds to anode current cut-off; signals of the form of Fig. 8 can thus be derived from terminal 94.

Where the neutralising pulses are of greater duration than the suppression pulses, the residual pulses are in the negative sense beyond the point corresponding to anode current cut-off in valve 84, and produce no change of anode current.

Since the amplitude (with respect to black) of the residual pulses before they are removed is dependent solely upon the amplitude of the neutralising pulses, which is kept constant, the D. C. component may be reinserted with reference to the peaks of these residual pulses before the latter are removed. It may be desirable to do this, for example, when the D. C. has been wholly or partially lost between the point at which it is first inserted and the point at which the residual pulses are removed.

Where these residual pulses are applied in the negative sense to the grid of a valve, the D. C. may be re-inserted with the aid of a diode rectifier in parallel with the grid circuit of the valve as described in British Patent specification No. 422,906.

In an alternative method of generating suppression and neutralising pulses of different durations, suppression pulses are generated in any convenient manner, and neutralising pulses are generated from the suppression pulses with the aid of a hexode valve. Referring to Fig. 15, the suppression pulses are applied directly and in the negative sense from terminals 99 to the outer control grid of a hexode valve 95 and through a delay network 96 which comprises inductances 97 and shunt condensers 98, and also in a negative sense, to the inner control grid. The outer control grid has a condenser 100 and a leak 101, while the inner grid has a condenser 102 and a leak 103. The anode is connected through resistance 104 to a source 105 of anode current, to a point in which the screening grids are also connected. It is arranged that the directly applied pulses cause the anode current of the hexode to fall to zero and that the pulses arriving through the delay network serve to hold the anode current at zero. The resulting pulses at the terminal 106 are therefore of longer duration than the suppression pulses. The suppression pulses, which are to be superimposed upon the picture signals, may be subjected to half the delay to which the signals applied to the inner grid of the hexode are subjected, so that the centre lines of the suppression and neutralising pulses are substantially coincident.

The methods above described for eliminating spurious signals from the line intervals may also be applied to remove spurious signals from the frame intervals. The frame intervals are usually longer than the line intervals and the suppression

and neutralising pulses are then made of suitably longer duration.

A further example of the present invention will now be described with reference to Figs. 16 to 24.

In Fig. 17 is shown a part of a picture signal. In this figure, as in Figures 19, 21, 22 and 24, the sense corresponding to an increase in brightness is indicated by an arrow W. In Fig. 17 the periods P are periods of scanning complete lines of the object and the periods P₁ are periods of scanning half lines of the object, the signals being those developed in interlaced scanning where the object is completely scanned in two traversals thereof, the lines traced out in one traversal interlacing with those traced out in the next traversal. The periods LI are the line intervals and the periods FI are the frame intervals. During these intervals spurious signals S may occur.

The signal of Fig. 17 does not contain the D. C. component and the zero line 0 therefore is such that the areas enclosed by the wave form above and below it are equal to one another.

The signal of Fig. 17 is applied to the grid of a valve 107 in Fig. 16 in such sense that signals in the direction W make the grid more negative. The valve 107 has a resistance 108 in its cathode circuit, and is arranged in such a way that the oscillations derived from the cathode substantially correspond to those applied to the grid. The anode of valve 107 is connected to the positive terminal of a source 109 of anode current. Oscillations from the cathode of valve 107 are applied to the control grid of a valve 110 through a condenser 111. A tetrode valve 112 is connected as shown between the grid and cathode of the valve 110, a resistance 113 being connected between the anode and cathode of the valve. The cathode potential of valve 112 is adjusted so that valve 110 is biased to a desired point on its characteristic, and for this purpose is connected to earth through a bias resistor 114 shunted by a condenser 115.

The anode and cathode of the tetrode 112 acts as a diode, and current flows through the diode on the positive peaks of the signal (that is the peaks in the black direction) thereby charging condenser 111 and making the grid of valve 110 more negative. The time constant of condenser 111 and resistance 113 is made long compared with the intervals P, (Fig. 17). When the steady state is reached, current will flow through valve 112 only on the extreme tips of the signals and D. C. will be established on the grid of valve 110. It will, however, be clear that parts of the spurious signals S may project beyond black into the blacker-than-black region and interfere with the insertion of D. C. by the device 111, 112, 113. To prevent this, negative pulses such as are shown in Fig. 18 are applied to the control grid of the valve 112 from a source 116. These pulses serve to stop current flow in the anode-cathode path of the valve 112 during the intervals LI and FI of Fig. 17 and so render the re-inserting device unresponsive to blacker-than-black peaks which may occur in these intervals. The re-insertion of D. C. is thus unaffected by the spurious signals and takes place with reference to the blackest parts of the picture signals in the intervals P and P₁. The resulting signal at the grid of valve 110 is shown in Fig. 19, the zero axis 0 corresponding to picture black.

The anode of valve 110 is connected to the anode of a tetrode valve 117 and through resistance 119 and a condenser 118 in parallel to

the grid of a valve 120. The anodes of valves 110 and 117 are connected to the positive terminal of source 109 through resistances 121 and 122, a decoupling condenser 123 being also provided.
 5 A resistance 124 is connected between the grid of valve 120 and earth, and the anode of this valve is connected to the positive terminal of source 109.

To the control grid of valve 117 is applied a
 10 signal which is of the form shown in Fig. 20 and is derived from source 116. The signal at the common anodes of valves 110 and 117 will thus be as shown in Fig. 21, the spurious signals S being displaced wholly beyond black level represented by the axis O in the blacker-than-black direction.

These signals are conveyed to the grid of valve 120 through coupling means, including elements 121, 122, 119, 124, 116 and 123, which serve to
 20 pass all frequency components of the signal, including zero frequency or D. C. The valve 120 is so adjusted that anode current ceases to flow at a signal level corresponding to black, so that at the cathode of this valve (which is connected to earth through resistance 125) the signal voltage
 25 has the form shown in Fig. 22, the axis O corresponding to black. This signal is applied to the grid of a valve 126, the cathode of which is connected to the cathode of another valve 127 and thence to earth through resistance 128. To the
 30 grid of valve 127 are applied synchronising signals of the form shown in Fig. 23 and the signal output from the cathodes of valves 126 and 127 will then have the form shown in curve 24. The
 35 signals of Fig. 23 are derived from source 129.

It will be seen that the spurious signals have been removed and the D. C. component has been inserted.

We claim:

40 1. In a television transmission system in which video signals having a direct current component and spurious signals are developed and in which the direct current component is suppressed in the passage of the video signals through the
 45 transmission apparatus, the method of re-inserting the direct current component exclusive of the spurious signals which comprises the steps of developing suppression waves, combining the suppression waves with the spurious signals to raise
 50 the amplitude level thereof, limiting the value of said combined waves to a value outside the range of the spurious signals, and re-inserting the direct current component at a portion of the system through which passes only the limited combined
 55 wave substantially simultaneously with the limiting thereof.

2. The method in accordance with claim 1 wherein there is provided the additional steps of developing neutralizing waves and combining the
 60 neutralizing waves with the limited waves in such phase as to remove substantially the limited waves.

3. In a television system wherein there is included means incapable of transmitting direct
 65 current and low frequency alternating current, means for developing trains of video signals having a direct current component from an object to be scanned, and in which there are included spurious signals, means for developing a signal
 70 fixedly related to a fixed shade in the object to be scanned, means for developing suppression pulses, means for combining said suppression pulses with said spurious signals whereby the level of said spurious signals is changed, and
 75 means for limiting the value of the combined

suppression pulses and spurious signals passed to the system to a value outside the range of said spurious signals, said latter means also acting to re-insert the direct current component of the video signal with respect to the signal fixedly
 5 related to a fixed shade in the object to be scanned.

4. Apparatus in accordance with claim 3 wherein said means for limiting the amplitude of the combined suppression pulse and spurious
 10 signal and also acting to re-insert the direct current component of the video signals comprises a thermionic tube having the input circuit thereof of such parameters as to block the current flow in the tube at an amplitude short of the spurious
 15 signal level and to maintain a substantially fixed bias on said input circuit of a value corresponding to the direct current component.

5. Apparatus in accordance with claim 3 wherein there is provided in addition means for
 20 cancelling the limited pulses said means comprising means for developing neutralizing pulses, and means for combining said neutralizing pulses with said limited pulses in such phase as to substantially cancel said limited pulses.

6. In a television system wherein there is included means incapable of transmitting direct current and low frequency alternating current, means for developing trains of video signals having
 30 a direct current component from an object to be scanned and in which there are included spurious signals, means for developing a signal fixedly related to picture black in the object to be scanned, means for developing suppression
 35 pulses, a thermionic vacuum tube having anode, cathode and at least one control electrode, means for combining said suppression pulses and said spurious signals in such phase as to increase the amplitude level of said spurious signals, means
 40 for impressing said combined spurious signals and suppression pulses onto the control electrode-cathode circuit of said thermionic tube, means for impressing said video signals and said signal fixedly related to picture black onto the control
 45 electrode-cathode circuit of said tube, a time constant circuit connected in the control electrode-cathode circuit of said tube having parameters of such value that said tube is blocked for wave amplitudes of the range of the spurious
 50 signal amplitude, and said control electrode is maintained at a substantially constant bias for waves corresponding to the signal fixedly related to picture black, whereby the spurious signals are removed, and the direct current component of the video signals is re-inserted by the same ther-
 55 mionic tube.

7. Apparatus in accordance with claim 6 wherein there is provided in addition means for
 60 cancelling the limited pulses said means comprising means for developing neutralizing pulses, and means for combining said neutralizing pulses with said limited pulses in such phase as to substantially cancel said limited pulses.

8. In a television system wherein there is included means incapable of transmitting direct
 65 current and low frequency alternating current, means for developing trains of video signals having a direct current component from an object to be scanned and in which there are included spurious signals, means for developing a signal
 70 fixedly related to picture black in the object to be scanned, means for developing suppression pulses, a thermionic vacuum tube having anode, cathode and at least one control electrode, means
 75 for combining said suppression pulses and said

spurious signals in such phase as to increase the amplitude of said spurious signals, means for impressing said combined spurious signals and suppression pulses onto the control electrode-cathode circuit of said thermionic tube, means for impressing said video signals and said signal fixedly related to picture black onto the control electrode-cathode circuit of said tube, a time constant circuit connected in the control electrode-cathode circuit of said tube having parameters of such value that said tube is blocked for wave amplitudes of the range of the spurious signal amplitude, said control electrode is maintained at a substantially constant bias for waves corresponding to the signal fixedly related to picture black, whereby the spurious signals are removed, and the direct current component of the video signals is re-inserted by the same thermionic tube, means for developing neutralizing pulses, means for combining said neutralizing pulses with the limited combined suppression pulses and spurious signals in such phase as to substantially cancel the limited combined suppression pulses and spurious signals, means for developing synchronizing signals in the intervals between trains of picture signals, and means for inserting said synchronizing signals during at least a portion of the interval during which the cancelled suppression pulses have been present.

9. Apparatus in accordance with claim 6 wherein there is provided in addition means for cancelling the limited pulses said means compris-

ing means for developing neutralizing pulses and means for combining said neutralizing pulses with said limited pulses substantially 180 degrees out of phase therewith, the neutralizing pulses and the suppression pulses having different durations.

10. Television transmitting apparatus comprising picture signal generating means of such nature that spurious signals may be generated in intervals between groups of picture signals, means for generating suppression pulses of predetermined suitable amplitude, means for mixing said pulses with said picture signals and spurious signals in the presence of the D. C. component of said picture signals, a hexode valve, means for feeding superimposed picture signals, spurious signals and suppression pulses to one control grid of said valve in such sense that an increase in picture brightness is represented by a positive signal, means for generating neutralising pulses of predetermined suitable amplitude, means for feeding said neutralising pulses to the other control grid of said valve in such sense as to drive the potential of that grid in the negative sense, and means for ensuring that, in intervals between successive neutralising pulses, a picture signal representative of black causes the flow of anode current substantially to cease.

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