

June 16, 1942.

E. L. C. WHITE ET AL

2,286,450

TELEVISION RECEIVING SYSTEM

Filed July 18, 1939

3 Sheets-Sheet 1

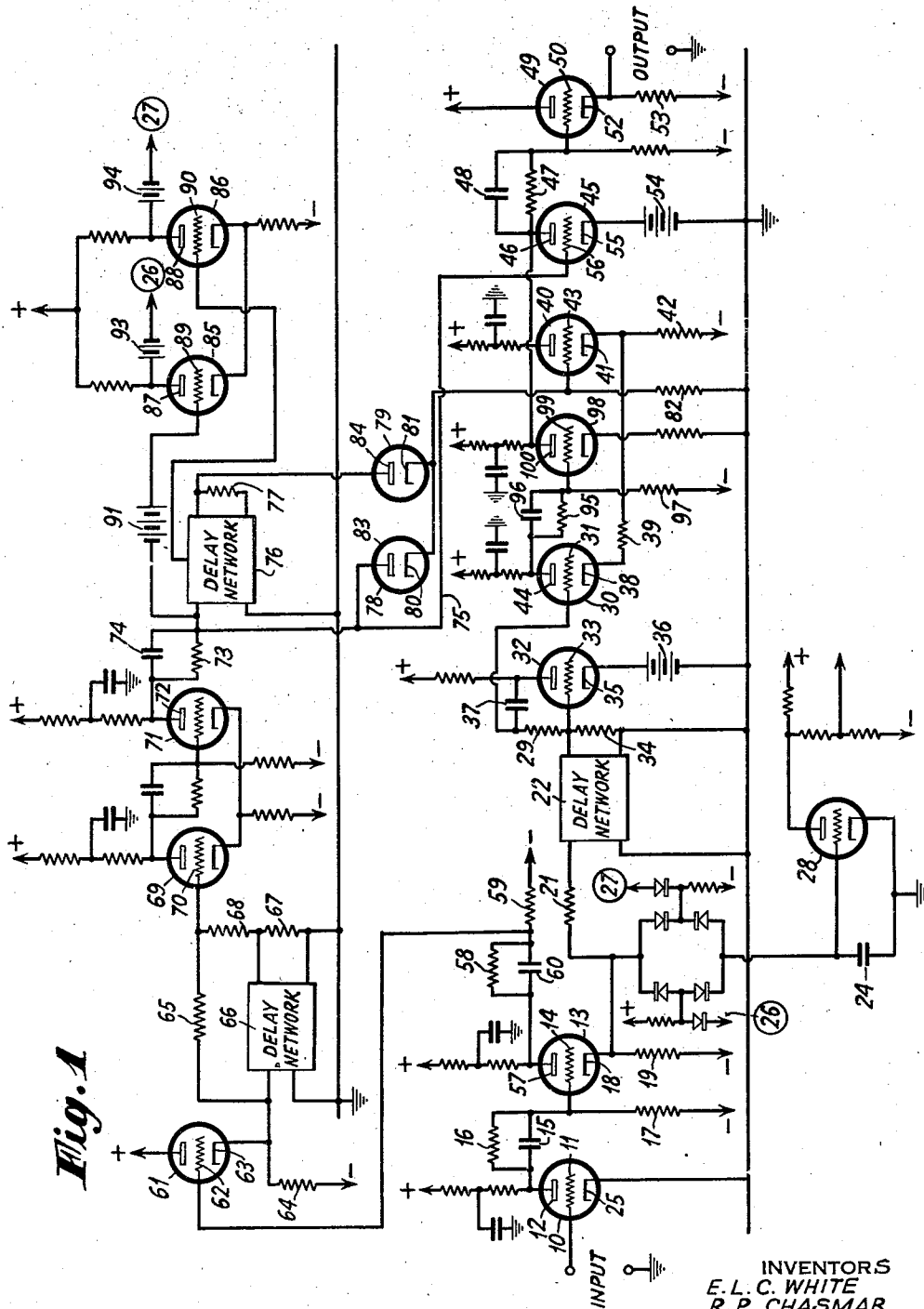


Fig. 1

INVENTORS
E. L. C. WHITE
R. P. CHASMAR
BY *H. S. S. S. S.*
ATTORNEY

June 16, 1942.

E. L. C. WHITE ET AL
TELEVISION RECEIVING SYSTEM

2,286,450

Filed July 18, 1939

3 Sheets-Sheet 2

Fig. 2a

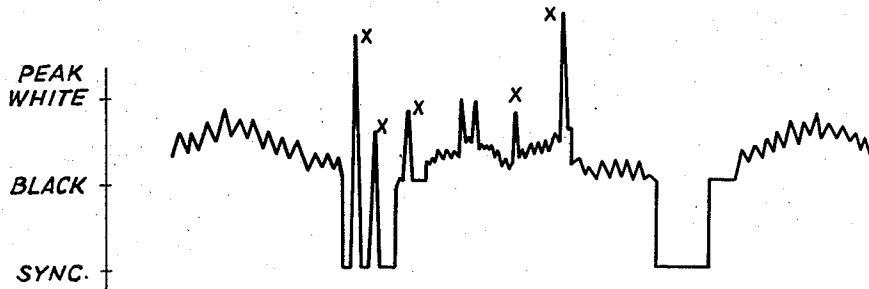


Fig. 2b

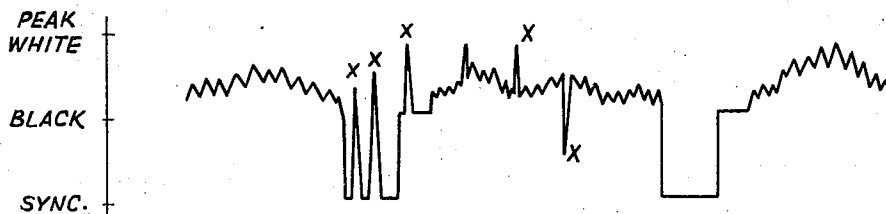
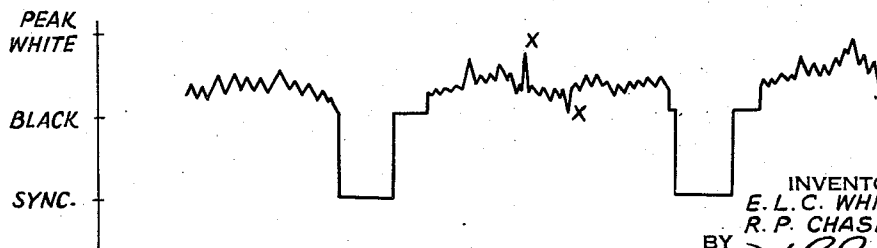


Fig. 2c



Fig. 2d



INVENTORS
E. L. C. WHITE
R. P. CHASMAR
BY *H. S. Stone*
ATTORNEY

June 16, 1942.

E. L. C. WHITE ET AL
TELEVISION RECEIVING SYSTEM

2,286,450

Filed July 18, 1939

3 Sheets-Sheet 3

Fig. 3

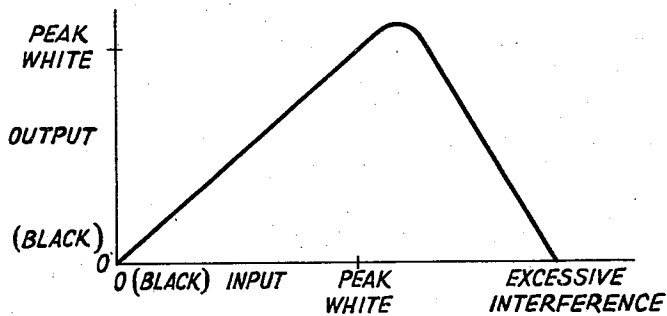
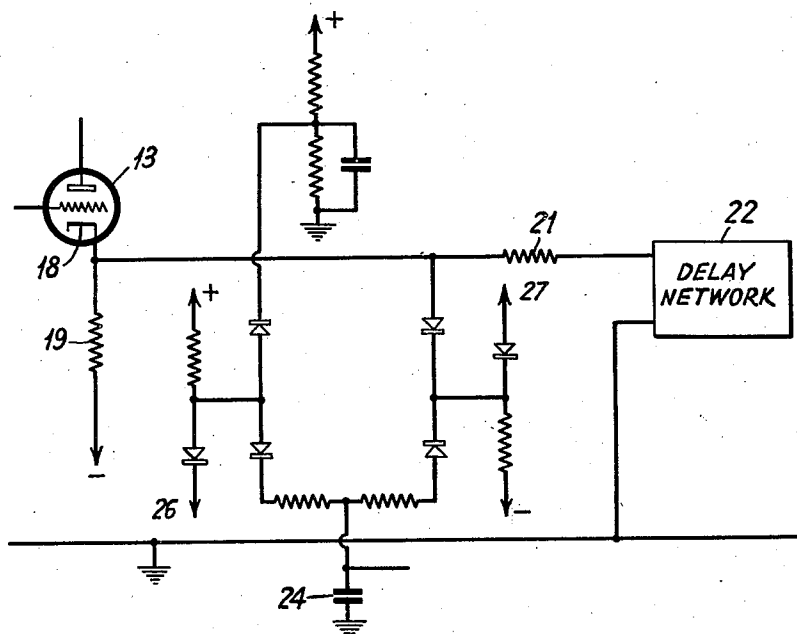


Fig. 4



INVENTORS
E. L. C. WHITE
R. P. CHASMAR
BY *H. S. Brace*
ATTORNEY

UNITED STATES PATENT OFFICE

2,286,450

TELEVISION RECEIVING SYSTEM

Eric Lawrence Casling White, Hillingdon, and
Reginald Philip Chasmar, Pinner, England, as-
signors to Electric & Musical Industries Lim-
ited, Hayes, Middlesex, England, a company of
Great Britain

Application July 18, 1939, Serial No. 285,062
In Great Britain July 20, 1938

6 Claims. (Cl. 178—7.3)

This invention relates to the suppression of interfering signals in a television transmission, and is concerned with the elimination of interference at receivers and more particularly but not exclusively those receivers employed in the course of transmission over a television relay system.

When a television signal containing a direct or slowly varying component is required to pass through a number of circuits in succession, as, for example, when a radio link is employed for relaying from an outside broadcast unit to a main transmitter, or from one main transmitter to another, it is usual to introduce means for effecting automatic gain control or automatic re-establishment of the black level at a predetermined value at various points in the system. Such means are described in the specification of United States Patent to Browne et al. #2,212,199, patented Aug. 20, 1940. Their operation depends in effect upon the observation of the black level for a period of about 5 microseconds after each synchronising pulse, and in general is interfered with in such a manner as to give rise to false correcting signals, if signals of the kind generated by car ignition systems are present during these "observation" periods. Moreover, succeeding circuits may be even more affected by interference of this kind occurring during the synchronising pulse and black level periods.

The object of this invention is to overcome defects of this nature and according to the invention in a system for the reception of television signals, said signals being interfered with by interfering signals, there are provided means for completely suppressing all of said signals during the intervals between the transmission of the picture signals of consecutive lines or of consecutive frames and for a period equal to the whole or to part of said intervals, and for reforming during said period the said television signals, so as to correspond to the original form of the said television signals prior to their being interfered with by said interfering signals, whereby the effect of said interfering signals is substantially overcome.

In some aspects of the invention the signals between successive lines may be only partially suppressed, i. e., for a duration corresponding only to the black level period and only the black level period re-formed in accordance with the invention. Preferably, however, all of the signals between lines are suppressed and both the synchronising pulses and the black level period re-formed in accordance with the invention.

According to a feature of the invention, prior to the suppression of said signals for said period, said interfering signals are limited to a predetermined value.

According to another feature of the invention, synchronising signals are added to said television signals after said suppression is effected.

According to a further feature of the invention, said suppression pulses are developed from the synchronising signals in said first mentioned television signals by separating said synchronising signals from the picture signals and lengthening them by an amount not greater than the duration of the black level period or by delaying them by this amount.

According to a further feature of the invention, after separation from said picture signals, said synchronising pulses are passed through a regenerating circuit which regenerates sharp pulses, free of said interference, said regenerating circuit being insensitive to short duration interference signals.

In order that the said invention may be the more readily understood, the same will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a circuit arrangement embodying the various features comprising the invention;

Figures 2a, 2b, 2c and 2d show the signal waveforms occurring at various points in the circuit;

Figure 3 shows the characteristic of a device preferably incorporated in the circuit for the purpose of limiting the magnitude of interference pulses; and

Figure 4 indicates a form of switching device suitable for employing in the circuit arrangement of Figure 1.

Referring to Figure 1, there are applied to the control grid 11 of valve 10, signals according to B. B. C. specification from a previous rectifier which are in the negative sense, i. e. signals in which the negative direction is one of increasing whiteness and in which the synchronising pulses are positive. The anode 12 of valve 10 is coupled to the control grid 14 of the valve 13 through the condenser 15 and the resistance 16, after the manner described in British patent specification No. 456,450, so that the direct and very low frequency components are transmitted, the control grid 14 being connected to a point of suitable negative potential through the resistance 17. From the cathode 18 of valve 13 in whose cathode circuit there is connected the resistance 19, the load is taken through the re-

istance 21 to the delay network 22 which provides a time delay of 1 microsecond, and through the six-diode (or four-diode) switching devices 23, to one plate of condenser 24, the other plate of this condenser being earthed as is the cathode 25 of valve 10.

By means of the switching device 23, which is operated by potentials applied at the points 26 and 27 and generated in a manner to be described later, the cathode 18 of the valve 13 is connected during the black level periods to the condenser 24. Across the condenser 24 there is, therefore, developed a potential difference which varies with the black level. This potential difference is applied between the control grid and the cathode of the valve 28, from the anode circuit of which a bias potential may be taken to control the gain of one or more amplifying valves situated earlier in the transmitting sequence. Since at the cathode of valve 13, the signals are in the positive sense, this bias potential operates in the correct sense to stabilise automatically the black level and no further phase reversal is required.

From the output of the delay network 22, the reason for which will become apparent later, connection is made through the resistance 29 to the grid 31 of the valve 30. At this point interference such as that denoted by the crosses, X, in Figure 2a is prevented from exceeding a certain value by means of the valve 32, which is arranged in the manner described in British patent specification No. 446,663. The grid 33 of this valve is connected to earth through the terminating resistance 34 of the delay network 22, and the cathode 35 is biased positively by means of the source of potential 36, so that for ordinary picture intensities the valve does not conduct. The bias potential due to the source 36, is however, so chosen that an interference signal incident upon the grid 33 of this valve renders it conducting and thereby impresses upon the grid 31 through the condenser 37 a potential which is in opposition to the potential that would otherwise occur at this grid. The characteristic of this device is in fact like that shown in Figure 3, and any interference greater than a certain value is converted into a signal or smaller magnitude. Figure 2b illustrates the effect of the device upon the interference signals indicated in Figure 2a. Since, however, it is possible for very strong interference signals to be reduced to a level below the black, the valve 30 is used to prevent these signals exerting an adverse effect upon synchronisation in later circuits, by removing the whole of the signals below the black level by anode bend limiting.

This valve 30 is coupled by cathode coupling from its cathode 38 through the resistance 39 to the cathode 41 of the valve 40, both valves 30 and 40 sharing the common cathode resistance 42. By means to be described later, positive pulses each lasting 15 microseconds and occupying the synchronising pulse and black level period are impressed on the grid 43 of the valve 40 with the result that a waveform of character shown in Figure 2c appears at the anode 44 of valve 30. This anode 44 is connected via the coupling resistance 95 and condenser 96 to the grid 99 of valve 98, the grid biasing resistance 97 being returned to a source of suitable negative potential. The valve 98 is employed merely for the purpose of changing the phase in order to facilitate the introduction of fresh synchronisation signals by means of the valve 45. Signals

in which the white direction corresponds to that of increasing positive potential are obtained at the anode 100. The anode 100 is directly connected to the anode 46 of valve 45, and is further connected through the resistance 47, which has shunted across it the condenser 48, to the grid 50 of valve 49, the grid 50 being taken through the resistance 51 to a point at a suitable negative potential. The output is taken from the cathode 52 of the valve 49 in whose cathode circuit there is connected the resistance 53; thus the anode 44 of valve 30 is coupled by direct coupling of the kind referred to previously, to the cathode follower output valve. The output would, therefore, be of the form shown in Figure 2c, but for the fact of the connection made to the anode of valve 45. This valve which is normally rendered non-conducting by means of the source of bias 54 to its cathode 55, has positive pulses lasting 10 microseconds and occupying the period of the synchronising pulses applied to its grid 56. By means of these positive pulses, which are generated in a manner to be described later, the waveform of Figure 2c is converted to that of Figure 2d, the addition of negative synchronising pulses being evident therein. These pulses and the associated black period portions, it will be seen, are similar to those shown in Figure 2a, but the interference present there has been removed. The suppression pulses and negative synchronising pulses may also be added in by the circuits described in U. S. Patent 2,212,199 supra, instead of by the circuit just described.

Passing now to the means for deriving the various pulses referred to previously, the anode 57 of valve 13 is coupled by means of the resistances 58 and 59 and the condenser 60, which allow of the passage of direct or slowly varying signal components as well as the higher frequency components, to the grid 62 of the valve 61 in the circuit of whose cathode 63 there is connected the resistance 64. The valve 61 is arranged to remove all signals, namely the negative picture signals, below the black level by means of anode bend limiting. The cathode 63 is coupled by way of the resistance 65 and through the delay network 66, which provides a delay of 1 microsecond and is terminated in the resistance 67, the connection through the delay network 66 including the resistance 68, to the grid 70 of the valve 69, which together with the valve 61 forms a directly coupled regenerator after the manner of that described in the specification of British Patent 373,309.

The pulse generator is triggered by the synchronising pulses, which are positive, appearing on the grid 70 and is so adjusted that a pulse must be present or absent simultaneously at the beginning and end of the delay network 66, in order to operate the circuit. Thus an interference pulse lasting 1 microsecond will normally fail to have any effect and the regenerator circuit will usually operate 1 microsecond after the beginning and end of a synchronising impulse incident at the grid of the cathode follower valve 61. From the circuit shown, it will be seen that there are obtained at the anode 72 of valve 71, pulses delayed by 1 microsecond which are free of interference and which last for a period of 10 microseconds. These pulses are conveyed by the coupling resistance 73 and condenser 74 and by the lead 75 to provide the 10 microseconds pulses required at the grid 56 of valve 45. The fact that these pulses must necessarily be delayed by 1

microsecond will render the inclusion of the 1 microsecond delay network 22 obvious.

In order to provide a pulse of 15 microseconds duration as required at the grid 43 of valve 40, the anode 72 of valve 71 is also connected through the coupling circuit 73, 74, to the input of the delay network 76, which is terminated in the resistance 77 and has a delay time of 5 microseconds; in addition the input and output of this delay network are taken respectively to the anodes 83 and 84 respectively, of the diodes 78 and 79, whose cathodes 80 and 81 are joined and connected to the grid 43 of valve 40, this grid being connected to earth through the resistance 82.

To provide switching pulses at the points 26 and 27 to operate the six-diode switching device 23 a push-pull arrangement of valves 85, 86, is employed, which is such as to generate short duration pulses at the anodes 87, 88, under the control of longer duration pulses applied to the grids 89 and 90. The grid 89 is connected through the source of positive bias 91 equal in magnitude to about half the magnitude of the applied impulses, to the input of the delay network 76. The other grid 90 is connected to a tapping point 92 on the delay network 76, at which a delay of 4 microseconds is attained. In this way pulses of 4 microseconds duration following immediately upon the synchronising impulses are obtained at the anodes 87 and 88. These switching pulses are conveyed to the switching device 23 through the sources of bias potential 93, 94 so that the black level may be effectively observed by the condenser 24 during the black level period.

In order to prevent the condenser 24 being charged up by positive interference, only the negatively conducting portion of the switching device 23 may be connected to the cathode of valve 13, the positively conducting portion being connected to a point of steady potential equal to or slightly more positive than that of the correct black level after the manner indicated in Figure 4. Alternatively, the positively conducting portion of the device 23 may be omitted entirely and replaced by a large leak resistance to a steady potential equal to or more positive than that of the correct black level.

Although the invention has been described with reference to signals transmitted according to the B. B. C. specification, it will be understood that the invention is not limited thereto, as it may be applied to other signals, such as those similar to the B. B. C. specification but with the synchronizing pulses positive and the picture signals negative, i. e., to the type of signal that has been standardised in the United States of America. In this case the black period following the synchronising pulses and lasting for a duration of five microseconds may be omitted and AVC automatic gain control may be derived from the amplitude of the synchronising pulses. Other types of signal are also possible.

We claim:

1. A television receiving system wherein picture and synchronizing signals are received as a single signal series and in which noise signals of relatively short duration may be simultaneously received comprising a discharge tube having a cathode, a control electrode and an anode, means for applying the received picture, synchronizing and noise signals to the control electrode of said tube, means for maintaining the anode positive with respect to the cathode and for so biasing the tube that current is passed thereby only upon the occurrence of strong noise

signals whereby counter-noise impulses are produced at the anode of said tube corresponding to the noise signals as received but out of phase with respect thereto, means responsive to the received synchronizing signals for producing re-formed synchronizing impulses free from noise disturbances, means cooperating with said discharge tube to reduce the intensity of the synchronizing impulses as received, and means for combining the received picture, and noise signals with the produced counter-noise impulses and the re-formed synchronizing impulses so as to substantially completely suppress the received noise signals.

2. A television receiving system wherein picture and synchronizing signals are received and in which extraneous noise signals of relatively short duration may be simultaneously received comprising an electron switching device, means for applying the received picture, synchronizing and noise signals to said switching device, said switching device being so biased as to be effective only upon the occurrence of noise signals to produce counter-noise impulses corresponding to the noise signals, means responsive to the received synchronizing signals for producing re-formed synchronizing impulses free from noise disturbances, means cooperating with said discharge tube to reduce the intensity of the synchronizing impulses as received, means for combining the produced counter-noise impulses with the received picture and noise signals in an out of phase relation so as to oppose the effect of the received noise signals and means to further combine the re-formed synchronizing impulses with the picture signals.

3. A television receiving system wherein picture and synchronizing signals are received as a single signal series and in which extraneous interference or noise signals of relatively short duration and of considerable amplitude may be simultaneously received comprising a discharge tube having a cathode, a control electrode and an anode, means for maintaining the anode positive with respect to the cathode, means for applying the received picture, synchronizing and noise signals to the control electrode of said tube with the synchronizing signals extending in a negative direction, said discharge tube being so biased as to become effective only upon the presence of noise signals having an amplitude greater than the normal amplitude of the picture signals whereby counter-noise impulses may be produced at the anode of said tube corresponding to the noise signals, means responsive to the received synchronizing signals for producing re-formed synchronizing impulses free from noise disturbances, means including said discharge tube to reduce the intensity of the synchronizing signals as received to a value corresponding to black in the picture, means for combining the produced counter-noise impulses with the received picture and noise signals in such a phase relationship that the noise signal will be substantially completely nullified, and means to further combine the re-formed synchronizing impulses with the picture signals.

4. A television system wherein picture and synchronizing signals are received as a single signal series and in which extraneous noise signals of relatively short duration and of considerable amplitude may be simultaneously received comprising a discharge tube having a cathode, a control electrode and an anode, means for maintaining the anode positive with respect to the

cathode, means for applying the picture, synchronizing and noise signals to the control electrode of said tube with the picture signal extending in a positive direction, the tube being so biased as to become conductive only upon the presence of noise signals having an amplitude in excess of the normal picture signal amplitude whereby counter-noise impulses are produced at the anode of said tube corresponding to the received noise signals but substantially out of phase therewith, means responsive to the received synchronizing signals for producing re-formed synchronizing impulses free from noise disturbances, means including said discharge tube to reduce the intensity of the synchronizing signals as received to a value corresponding substantially to black, and means for combining the received picture and noise signals with the produced counter-noise impulses and the re-formed synchronizing impulses whereby those portions of the signal series during which noise signals are received may be reduced to an amplitude corresponding substantially to black.

5. A television receiving system wherein picture and synchronizing signals are received as a single signal series and in which extraneous noise signals of relatively short duration may be simultaneously received comprising an asymmetric unit, means for applying the received picture, synchronizing and noise signals to the asymmetric unit, said asymmetric unit being so biased as to become conductive only upon the presence of noise signals having an amplitude in excess of the normal picture signals to produce counter-noise impulses corresponding to the received noise signals, means for combining the received picture and noise signals with the counter-noise impulses in substantially out of phase relationship whereby the noise signals received with the picture signals may be reduced to substantially black picture level, means for limiting the strength of the so combined signals to a level corresponding to black picture signal, means responsive to the received synchronizing signals for producing noise free synchronizing impulses of a predetermined polarity and time duration cor-

responding to synchronizing signals, and means for combining the limited signal series with the produced noise free synchronizing impulses whereby the effect of the noise signals may be substantially entirely eliminated.

6. A television receiving system wherein picture and synchronizing signals are received as a single signal series with the synchronizing signals corresponding to blacker than black picture signals and in which extraneous noise signals of relatively short duration and of considerable amplitude may be simultaneously received comprising a discharge tube having a cathode, a control electrode and an anode, means for applying the received picture, synchronizing and noise signals to the control electrode of said tube with the picture signals extending in a positive direction, means for maintaining the anode of said tube positive with respect to the cathode, and for biasing said tube whereby current is passed thereby only when noise signals having an amplitude in excess of white picture signals are impressed thereon to produce counter-noise impulses at the anode of said tube corresponding to the applied noise signals but out of phase therewith, means including a second discharge tube for combining the received picture, synchronizing and noise signals with the produced counter-noise impulses so as to produce in the combined signal series voltage amplitudes corresponding to black in the picture during those intervals when noise signals are received, means for limiting the combined signals in the black direction to black picture signal level whereby the received synchronizing signals are removed, impulse generating means responsive to the received synchronizing signals for generating new noise free synchronizing signals, and means for combining the generated noise free synchronizing signals with the limited picture signal series whereby the resultant combined picture and synchronizing signal series will be substantially devoid of noise signals.

ERIC LAWRENCE CASLING WHITE.
REGINALD PHILIP CHASMAR.