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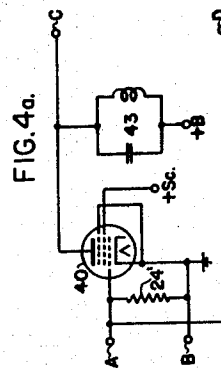
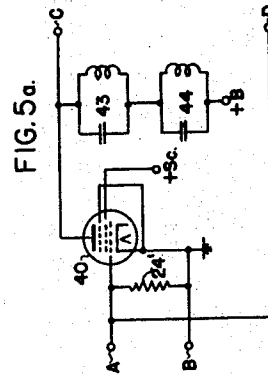
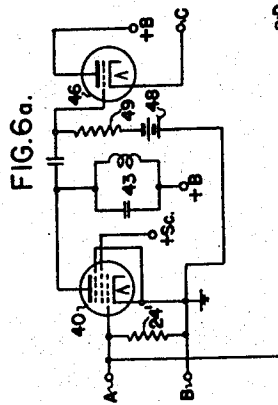
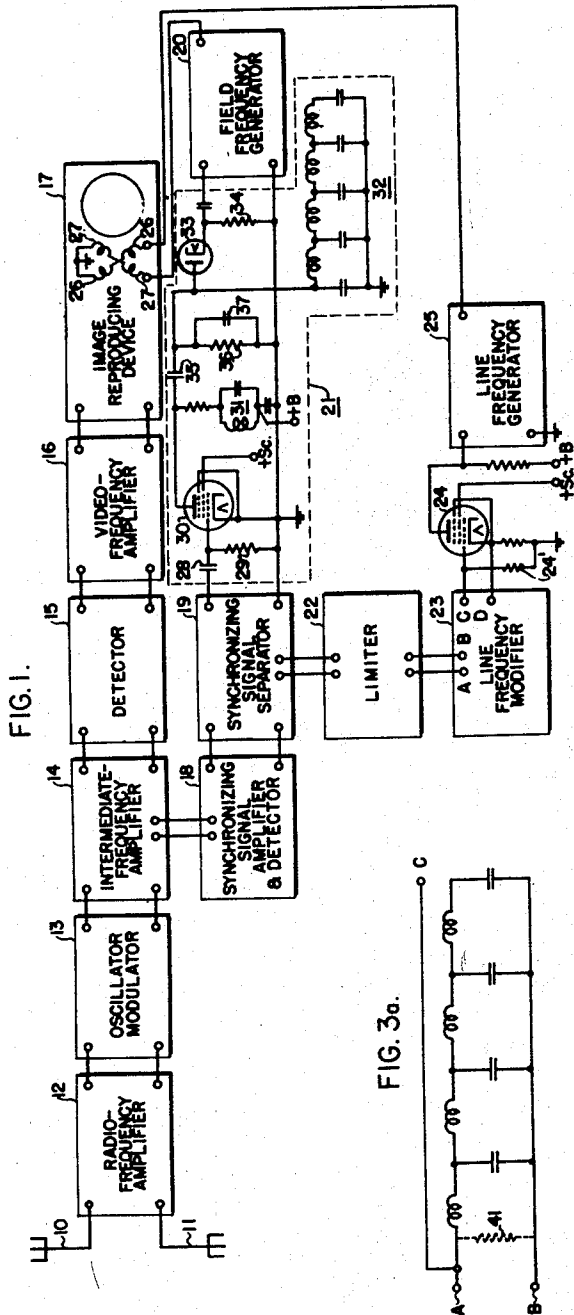
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2,416,424

SYNCHRONIZING SIGNAL SEPARATOR

Filed March 16, 1939

2 Sheets-Sheet 1



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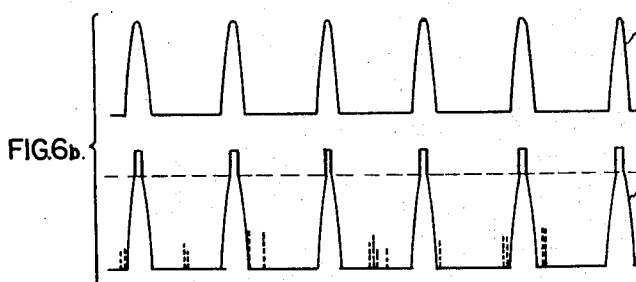
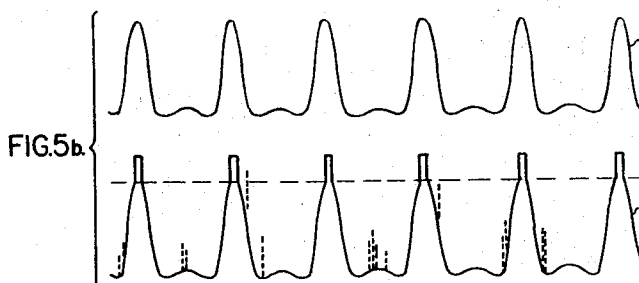
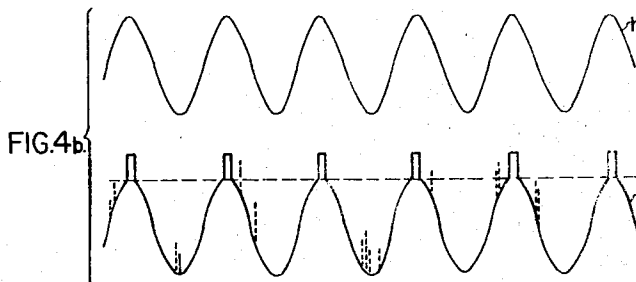
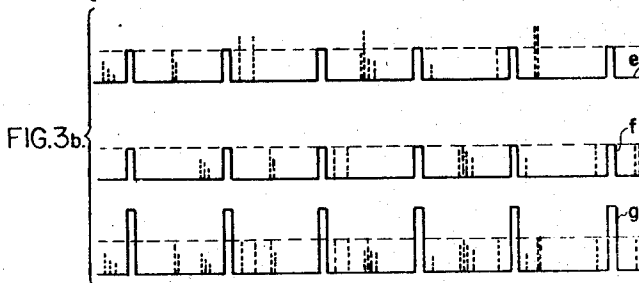
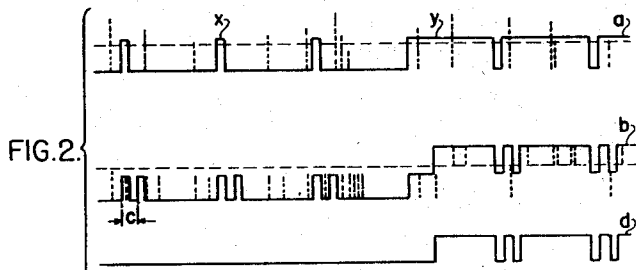
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SYNCHRONIZING SIGNAL SEPARATOR

Filed March 16, 1939

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,416,424

SYNCHRONIZING-SIGNAL SEPARATOR

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Application March 16, 1939, Serial No. 262,146

14 Claims. (Cl. 178-7.5)

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This invention relates generally to synchronizing-signal separators for television receivers and particularly to separators in which there is an interval after each desired synchronizing pulse in which the separator acceptance is low or zero for any undesired or spurious pulses.

In television receiver scanning systems, it is very difficult in some instances to synchronize the scanning generator from desired synchronizing pulses included in a signal containing undesired pulses or random pulses such as those caused by static. Some scanning systems of the prior art have utilized a saw-tooth scanning oscillator which is insensitive to undesired pulses occurring within a certain portion of each cycle after the tube utilized in the oscillator has fired. Other systems of the prior art have utilized synchronizing-signal separator circuits which are blocked against undesired disturbances during given portions of each cycle. For instance, a vacuum-tube switching circuit has been utilized in such systems, which circuit has a low value of conductance except during the interval when a delayed pulse is fed to its input circuit from a succeeding part of the circuit by means of a delay network. In some instances, however, it is desirable to provide a synchronizing-signal separator circuit in which the acceptance is low or zero for any undesired pulse. The difference between systems of the latter type and those of the former type lies in the behavior of the circuit during the interval between successive desired synchronizing pulses. In systems of the latter type, it is essential that the circuit distinguish between desired and undesired pulses in regard to their ability to lower the circuit acceptance because otherwise the circuit may spend the major portion of the cycle artificially blocked. It has previously been proposed to provide a synchronizing-signal separator for a television receiver in which the signal comprising the desired pulses is added to a similar signal having a given time delay such that corresponding desired pulses in the resultant signal occur during the same interval and undesired corresponding pulses occur at different intervals. Such a resultant signal may be limited to obtain the desired synchronizing pulses by amplitude separation. However, in such systems, undesired pulses of short duration, such as static disturbances, may occur with an amplitude comparable to the amplitude of the added components of corresponding desired pulses in the resultant signal and thus may cause an operation which is entirely unsatisfactory.

It is an object of the present invention, there-

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fore, to provide an improved synchronizing-signal separator of the character described for television receivers, which is not subject to the above-mentioned disadvantages of separator circuits of the prior art.

In accordance with the invention, a synchronizing-signal separating apparatus is provided for a television receiving system that includes an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals. The synchronizing-signal separating apparatus is used for separating from the separated synchronizing signal containing undesired random pulses, desired pulses of predetermined amplitude, duration, and periodicity. This apparatus comprises means for deriving from the separated synchronizing signal a first signal which is limited to an amplitude less than twice the amplitude of the desired synchronizing pulses, and which comprises the desired pulses and the undesired pulses. The apparatus also has means for deriving from the separated signal a second signal having periodic maximum values occurring during the intervals of the desired synchronizing pulses and in which any component of the random pulses appears, if at all, with an amplitude not greater than that of the desired pulses and in a phase relation different from that of the corresponding component random pulses in the first-derived signal. The apparatus further has means for adding the first and second derived signals and for again limiting the resultant signal so obtained to obtain the desired synchronizing pulses by amplitude separation.

In a preferred embodiment of the invention, the above-mentioned second signal corresponds substantially to that of the first signal with a given time delay so that any component of the random pulses appears in the resultant signal in a time relation different from that of a corresponding component of the random pulses in the first signal. In another embodiment of the invention, the second signal is one which is not delayed in time with respect to the first signal but in which all components of the random pulses are substantially suppressed; that is, the wave form is smoothed out so that they do not appear.

Another feature of the invention relates to an electrical system, such as a synchronizing-signal separator, employing time-spaced pulse signals. The system has means actuated by desired pulses

but subject to actuation by undesired pulses, means for producing a sinusoidal voltage wave having a predetermined frequency relation to the frequency of occurrence of the desired pulses, as well as means for utilizing the sinusoidal voltage wave to decrease the responsiveness of the first-mentioned means to the undesired pulses.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 is a circuit diagram, partially schematic, of a television receiver or reproducing system including field-frequency and line-frequency synchronizing-signal separators in accordance with different embodiments of the present invention; Fig. 2 is a graph of certain of the wave forms developed in the field-frequency signal separator of Fig. 1; Figs. 3a, 4a, 5a, and 6a are diagrams of different specific embodiments of the line-frequency synchronizing-signal separator of the circuit of Fig. 1; while Figs. 3b, 4b, 5b, and 6b represent certain wave forms appearing in the circuits of Figs. 3a, 4a, 5a, and 6a, respectively.

Referring now more particularly to the drawings, the system illustrated in Fig. 1 comprises a television receiver of the superheterodyne type including an antenna system 10, 11 connected to radio-frequency amplifier 12 to which is connected in cascade, in the order named, an oscillator-modulator 13, an intermediate-frequency amplifier 14, a detector 15, a video-frequency amplifier 16, and an image-reproducing device 17, which may comprise a cathode-ray signal-reproducing tube, these stages or units constituting the main signal-translating channel of the receiver. Neglecting for the moment the details of the portions of the synchronizing-signal channels constituting the present invention, there is provided a synchronizing-signal amplifier and detector 18 having an input circuit coupled to intermediate-frequency amplifier 14 and an output circuit connected to synchronizing-signal separator 19. A field-frequency generator 20 is coupled to the synchronizing-signal separator 19 through field-frequency signal separator 21, presently to be described, and to deflecting coils 27 for supplying thereto a scanning current of saw-tooth wave form. A line-frequency generator 25 is also provided, having an input circuit coupled to synchronizing-signal separator 19 through a network including limiter 22, line-frequency modifier 23, and repeater 24, presently to be described, for supplying a current of saw-tooth wave form to line-frequency scanning coils 26. The stages or units 10-20, inclusive, and 25 may all be of conventional well-known construction so that detailed illustrations and descriptions thereof are deemed unnecessary herein.

Referring briefly, however, to the operation of the system described above, television signals intercepted by antenna circuit 10, 11 are selected and amplified in radio-frequency amplifier 12 and supplied to the oscillator-modulator 13 wherein they are converted into intermediate-frequency signals which, in turn, are selectively amplified in the intermediate-frequency amplifier 14 and delivered to the detector 15. The modulation-frequency components of the received signal are derived by the detector 15 and are supplied to the video-frequency amplifier 16 wherein they are amplified and from which they

are supplied, in the usual manner, to a brilliancy-control element of image-reproducing device 17. The intensity of the scanning beam of the device 17 is thus modulated or controlled in accordance with the light-modulation voltages impressed on the control element of the device in the usual manner.

Saw-tooth current waves generated in the line-frequency and field-frequency generators 25 and 20, respectively, which are controlled by synchronizing-voltage pulses supplied from the apparatus of this invention presently to be explained, are applied to the scanning coils 26, 27 of the device 17 to produce electromagnetic-scanning fields, thereby to deflect the scanning ray in directions normal to each other so as to trace a rectangular scanning pattern on the screen of the tube to reconstruct the transmitted image.

Referring now more particularly to the portions of the system of Fig. 1 embodying the present invention, there is provided apparatus for deriving from the received composite signal the line-frequency and field-frequency synchronizing-signal components separate from the vision-signal components and from each other, as well as from random undesired pulses, such as static. There is, therefore, provided in the field-frequency synchronizing-channel means for limiting the amplitude of the received field-frequency synchronizing signal to an amplitude less than twice the amplitude of the desired pulses, means for delaying the limited signal for a time less than the duration of the desired field-synchronizing pulses, means for adding the limited signal and the delayed signal, and means for limiting the resultant signal to obtain the desired field-frequency synchronizing pulses for generator 20. In order to limit the amplitude of the field-frequency synchronizing-signal output of separator 19 to an amplitude less than twice that of the desired field-frequency synchronizing pulses, there is provided a vacuum tube 30 having input electrodes coupled to separator 19 and an output circuit including impedance network 31 across which the desired limited voltage appears. Grid condenser 28 and leak resistor 29 serve to bias tube 30 to provide limiting at the desired signal level. The constants of the input circuit 28, 29 and the output network 31 of tube 30, together with the operating potentials therefor, are so chosen that the tube is operated over its lower cutoff point by the applied signals, thus to provide the desired limiting function in a manner well understood in the art. There is coupled across impedance network 31 a time-delay network, shown as an open circuit dead-end reflecting filter 32, the image impedance of which matches the impedance of network 31 at their junction. Time-delay network 32 comprises a ladder network or filter including series inductances and shunt condensers, the filter being mismatched at the end remote from network 31 to provide reflection and time delay in a known manner. The operation and characteristics of such a filter are completely described in applicant's copending application Serial No. 226,875, filed August 26, 1938, and which has now matured into United States Letters Patent No. 2,188,970, issued February 6, 1940. Diode 33 coupled across impedance network 31 through load resistor 34, by means of coupling condenser 35, is provided for limiting the resultant wave comprising the signal limited by tube 30 and the delayed output of reflecting filter 32 to obtain the desired field-frequency synchronizing pulses for generator 20.

Parallel-connected resistor 36 and condenser 37 serve to bias diode 33 properly to procure the desired limiting function

Reference is made to Fig. 2 for an explanation of the operation of the field-frequency separator of the invention illustrated in Fig. 1. A portion of the characteristic wave form appearing at the output terminals of separator 19, with the vision-modulation signal deleted, is illustrated by curve *a* of Fig. 2. This wave form comprises conventional narrow line-synchronizing and broad field-synchronizing pulses *x* and *y*, respectively, upon which are superimposed random pulses such as static, the amplitude, duration, and timing of the static pulses being indicated by the vertical dotted lines. This wave is applied to the input electrodes of vacuum tube 30 with the pulses *x* and *y* negative and, due to the bias provided by condenser 28 and resistor 29, the signal output of vacuum tube 30 is limited by anode cutoff at a point corresponding to the horizontal dotted line on curve *a* of Fig. 2. This limited wave form is thus applied to reflecting filter 32 and to diode 33 and there is also applied to diode 33 the delayed output of reflecting filter 32, which has a wave form similar to that of curve *a*, but which is delayed in time by a period less than the duration of one of the broad field-synchronizing pulses of curve *a* but greater than the duration of the narrow line-synchronizing pulses *x*. The addition of these two limited voltages is illustrated in curve *b* of Fig. 2, the delay provided by network 32 being indicated as *c*. It will be seen that the original narrow line-frequency pulses *x* appear in the resultant wave at times different than the times of corresponding delayed line-frequency pulses, so that these pulses are staggered, while each original broad pulse *y* has superimposed thereon a portion of a delayed broad pulse. It will also be seen that the random undesired pulses, indicated by the vertical dotted lines, occur, in general, at different points in the original and in the delayed wave form so that corresponding random components are not added in the resulting wave form.

Diode 33 performs the function of limiting the wave form *b* along the horizontal dotted line of curve *b* to provide an output comprising only the desired field-synchronizing pulses, free from disturbing pulses, as illustrated by curve *d*, this output being utilized to synchronize the field-frequency generator 20.

The capacitance of network 31 is preferably made large enough to provide a substantial amount of integration in order to reduce the effects of any residual undesired random pulses which may occur in the field-frequency synchronizing-signal wave form.

In order to provide the separated line-frequency synchronizing signal for line-frequency scanning generator 25, there is provided a limiter 22 having input terminals coupled to synchronizing-signal separator 19 and output terminals coupled directly to input terminals A, B, of line-frequency synchronizing-signal modifier 23, the output terminals C and D of which are coupled to the input electrodes of tube 24, as shown, the output electrodes of tube 24 being, in turn, coupled to the input terminals of generator 25. The units 22, 23, and 24 may co-operate to provide line-frequency synchronizing-signal separation in different manners which will be more fully described in connection with Figs. 3a, 4a, 5a, and 6a, respectively.

Thus, in Fig. 3a there is illustrated a reflecting

filter of a type similar to filter 32 of Fig. 1 and having input terminals A, B and an output terminal C, and having its dead-end terminals open-circuited. The filter of Fig. 3a may be utilized as the line-frequency synchronizing-signal modifier 23 of Fig. 1 by coupling its terminals A, B, and C, respectively, directly to terminals A, B, and C of Fig. 1. The input image impedance of the filter of Fig. 3a is represented by dotted resistance 41 and it will be understood that the image impedance of the filter is matched by the resultant impedance of the circuits of limiter 22 and vacuum tube 24, to which the filter is coupled, in order to prevent reflection at the terminals of the filter. It will be understood that no connection is made to terminal D of vacuum tube 24 in case the embodiment of Fig. 3a is utilized in the circuit of Fig. 1.

Reference is made to Fig. 3b for a description of the operation of the line-frequency synchronizing-signal separator of Fig. 1 utilizing the signal modifier 23 illustrated in Fig. 3a. A portion of the wave form of the received line-frequency synchronizing signals is illustrated in curve *e* having superimposed thereon random pulses which may, for instance, be caused by static and indicated by the vertical dotted lines. Limiter 22 performs the function of limiting this wave along the dotted horizontal line of curve *e*. The reflecting filter of Fig. 3a is designed to provide a delay of exactly the line-scanning period of the system or an integral multiple thereof, as illustrated by curve *f*, so that corresponding line-frequency pulses are superimposed when the limited signal and the delayed signal are added at the input of vacuum tube 24 as illustrated by curve *g*. The random undesired pulses are not, in general, added in the resultant wave and, therefore, the desired line-frequency synchronizing signals, free from disturbing pulses, can be obtained by limiting the wave of curve *g* along the dotted horizontal line. Tube 24 in the circuit of Fig. 1 provides this last-mentioned limiting function due to the bias provided by resistor 24'.

The circuit of Fig. 4a is an alternative which may be utilized in place of the circuit of Fig. 3a as line-frequency synchronizing-signal modifier 23 of Fig. 1. The circuit of Fig. 4a comprises a parallel-resonant circuit 43, resonant at the line-scanning frequency of the receiver, coupled to terminals A and B through a vacuum tube 40 and directly to output terminals C and D, as shown. The circuit of Fig. 4a may be coupled into the circuit of Fig. 1 by connecting terminals A—D, inclusive, of Fig. 4a to corresponding terminals of Fig. 1.

In considering the operation of the modification of the invention illustrated in Fig. 4a, it will be seen that there is applied to terminals A, B a voltage of the wave form of limited curve *e* of Fig. 3b. The output wave form of the tuned circuit 43 with such excitation is illustrated by curve *h* of Fig. 4b, this output wave being applied to the input electrodes of tube 24 through terminals C, D. There is also applied to the input electrodes of tube 24, in series with the voltage applied at terminals C, D, by means of the direct coupling path from limiter 22, a voltage of the wave form of limited curve *e*. These input voltages to vacuum tube 24 are added in the manner illustrated in curve *i*, it being seen that the desired line-frequency synchronizing pulses occur at the intervals of maximum value of curve *h* and, therefore, curve *i* has its maximum amplitude during these intervals. The undesired ran-

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dom signals occur, in general, at other times and combine with curve *h* to provide amplitudes of very much lower values than the maximum values of curve *i*. The desired synchronizing signals, free from disturbing pulses, are obtained by limiting curve *i* along the dotted horizontal line, this function being performed by tube 24 in the manner described above.

The modification of the invention illustrated by the circuit of Fig. 5a is similar to that illustrated in Fig. 4a and differs therefrom only in that there are provided two parallel-resonant tuned circuits 43 and 44 connected in series across the output electrodes of tube 40, one of the tuned circuits being resonant at the line-scanning frequency and the other being resonant at twice the line frequency. The output voltage of tube 40 of the circuit of Fig. 5a, with an excitation in accordance with the wave form of limited curve *e*, is illustrated in curve *j*. It will be seen that the points of maximum amplitude of curve *j* are much more sharply peaked than those of corresponding curve *h*. Curve *k*, illustrating the performance of the circuit of Fig. 5a, corresponds to curve *i* utilized above in illustrating the performance of the circuit of Fig. 4a. It will be seen that a wave form in accordance with curve *k* is effective to eliminate even more of the undesired random pulses than are eliminated by the circuit of Fig. 4a.

In Fig. 6a there is illustrated still another circuit modification which may be utilized as line-frequency synchronizing-signal modifier 23 in the circuit of Fig. 1. The circuit of Fig. 6a is similar to the circuit of Fig. 4a, and comprises, in addition, a vacuum tube 46 having input terminals connected across circuit 43 and output electrodes coupled to the input circuit of tube 24. A bias is provided for the input electrodes of tube 46 by means of direct potential source 48 and resistor 49.

In considering the operation of the circuit of Fig. 1 utilizing the line-frequency signal modifier of Fig. 6a, it will be seen that a wave form in accordance with that of curve *h* is applied to the input electrode of tube 46, and that, with the proper bias on tube 46, the output wave form at terminals C, D may be in accordance with that of curve *l* of Fig. 6b. The output wave form corresponding to curve *l* and the wave form supplied directly from limiter 22 are added in the input circuit of vacuum tube 24 in a manner illustrated by curve *m*, corresponding, in general, to curve *i* utilized to illustrate the operation of the circuit of Fig. 4a. The tube 24 then serves to limit the wave form of curve *m* along the dotted horizontal line so that, in this modification of the invention, it is seen that substantially all random undesired pulses are eliminated from the desired line-synchronizing signals.

It will be understood that there may also be obtained an advantage by adding successive stages of limiting, delay, and recombination in accordance with the invention. Every time the process is repeated it diminishes the probability of passage of interference through to the output of the system.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes

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and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude of less than twice the amplitude of said desired pulses and comprising said desired pulses and said undesired pulses, means for deriving from said separated signal a second signal having periodic maximum values corresponding in periodicity and phase with said desired pulses and in which the undesired random pulses appear if at all in a time distribution statistically different from that of the corresponding random pulses in said first derived signal, means for adding said first and second derived signals, and means for limiting the resultant signal to obtain said desired pulses.

2. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited in amplitude to less than twice the amplitude of said desired synchronizing pulses and comprising said desired pulses and said undesired pulses and for deriving from said separated signal a second signal limited to an amplitude of less than twice the amplitude of said desired signal and delayed with respect to said first signal by an interval such that the desired pulses of said second signal and the desired pulses of said first signal at least in part coincide in time, means for adding said first and said second signals, and means for limiting the resultant signal to obtain said desired synchronizing pulses.

3. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude of less than twice the amplitude of said desired synchronizing pulses and comprising said desired pulses and said undesired pulses, means for deriving from said first limited signal a second signal delayed in phase by such an amount that the desired pulses of said limited signal and the desired pulses of said delayed signal at least in part

coincide in time, means for adding said first and second derived signals, and means for limiting the resultant signal to obtain said desired pulses.

4. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a signal limited to an amplitude of less than twice the amplitude of said desired synchronizing pulses and comprising said desired pulses and said undesired pulses, means for delaying said limited signal for a time less than the duration of said desired pulses, means for adding said limited signal and said delayed signal, and means for limiting the resultant signal to obtain said desired pulses.

5. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude of less than twice the amplitude of said desired synchronizing pulses and comprising said desired pulses and said undesired pulses and for deriving from said separated signal a second signal having an amplitude limited to less than twice the amplitude of said desired synchronizing pulses and delayed with respect to said first signal for a time approximately equal to an integral multiple of the period of said desired pulses, means for adding said first and said second signals, and means for limiting the resultant signal to obtain the desired synchronizing pulses.

6. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of a predetermined amplitude, duration and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude less than twice the amplitude of said desired pulses and comprising said desired pulses and said undesired random pulses, means for deriving from said separated signal a second signal having periodic maximum values occurring during the intervals of said desired pulses and in which the components of said undesired pulses are suppressed, means for adding said first and second derived signals, and means for limiting the resultant signal to obtain said desired pulses.

7. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that un-

desired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude less than twice the amplitude of said desired pulses and comprising said desired pulses and said undesired pulses, means for deriving from said separated signal a second signal having periodic maximum values occurring during the intervals of said desired pulses and in which components of said random pulses are suppressed, means comprising a vacuum tube for adding said first and second derived signals, and means comprising said vacuum tube for limiting the resultant signal to obtain said desired pulses.

8. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired synchronizing pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a first signal limited to an amplitude less than twice the amplitude of said desired pulses, and comprising said desired pulses and said undesired pulses, means comprising a circuit resonant at the periodicity of said desired pulses for deriving from said separated signal a second signal having periodic maximum values occurring during the intervals of said desired pulses and in which components of said random pulses are suppressed, means for adding said first and second derived signals, and means for limiting the resultant signal to obtain said desired pulses.

9. In a television receiving system including an arrangement for separating the synchronizing signal from a received video signal such that undesired random pulses of amplitude greater than twice the amplitude of the synchronizing signals may occur with the separated synchronizing signals, synchronizing-signal separating apparatus for separating from said separated synchronizing signal containing undesired random pulses desired pulses of predetermined amplitude, duration, and periodicity comprising, means for deriving from said separated signal a signal limited to an amplitude less than twice the amplitude of said desired pulses and comprising said desired pulses and said undesired pulses, a vacuum tube having input and output electrodes, a circuit resonant at the periodicity of said desired pulses coupled to the input circuit of said vacuum tube, and means comprising said resonant circuit and said vacuum tube for deriving from said separated signal a signal having periodic maximum values occurring during the intervals of said desired pulses and in which components of said random pulses are suppressed, for adding said limited signal and said derived signal, and for limiting the resultant signal to obtain said desired pulses at said output electrodes of said vacuum tube.

10. In an electrical system employing time-spaced pulse signals and including means ac-

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tuated by desired pulses but subject to actuation by undesired pulses, the method of lessening the possibility of response to said undesired pulses, which consists in producing a sinusoidal voltage wave having a predetermined frequency relation to the frequency of occurrence of said desired pulses, and utilizing said voltage wave in a manner to decrease the responsiveness of said means to the undesired pulses.

11. In an electrical system employing time-spaced pulse signals and including means responsive to pulses exceeding a predetermined amplitude level, the method of lessening the possibility of response to undesired pulses, which consists in producing a sinusoidal voltage wave at least some of whose peaks occur in substantial coincidence with the desired pulses, and combining said voltage wave with said pulse signals thereby to raise the desired pulses above said amplitude level and to lower the undesired pulses below said amplitude level.

12. In an electrical system employing time-spaced pulse signals, means actuated by desired pulses but subject to actuation by undesired pulses, means for producing a sinusoidal voltage wave having a predetermined frequency relation to the frequency of occurrence of said desired pulses, and means for utilizing said voltage wave to decrease the responsiveness of said first means to the undesired pulses.

13. In an electrical system employing time-spaced pulse signals, means actuated by desired pulses but subject to actuation by undesired pulses, a resonant circuit energized by pulse sig-

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nal energy to produce a sinusoidal voltage wave having a predetermined frequency relation to the frequency of occurrence of said desired pulses, and means for utilizing said voltage wave to decrease the responsiveness of said first means to the undesired pulses.

14. In an electrical system employing time-spaced pulse signals, means responsive to pulses exceeding a predetermined amplitude level, means for producing a sinusoidal voltage wave at least some of whose peaks occur in substantial coincidence with the desired pulses, and means for combining said voltage wave with said pulse signals thereby to raise the desired pulses above said amplitude level and to lower the undesired pulses below said amplitude level.

JOHN C. WILSON.

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